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November 1980/$1.25

WEEDS TREES & TURF

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Turf Management Series, Part 5—Diseases

Update on Dutch Elm Disease

ISSN 0043-1753

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WT&T

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WT&T

OUTLOOK

By Bruce F. Shank, Editor

When Weeds Trees & Turf was born in 1962 as a section in Pest Control Magazine, no one imagined it would become a $1 million property with offices in the publishing center of the world, New York City. That's what I said, New York City.

The November issue of Weeds Trees & Turf is brought to you by one of the world's most respected publishing houses, Harcourt Brace Jovanovich, Inc. Perhaps if I named a few publications by HBJ you will understand better. How about Instructor Magazine, Modern Medicine, Home & Auto, Rent All, Dental Management, Housewares, Ready to Wear, Food Management, Hotel & Motel Management, Snack Food, and Professional Remodeling? HBJ is also a top publisher of books to schools and universities in the U.S. and foreign countries.

More important is what this means to you, the subscriber. I assure you, as editor, the standards will go up, not down. There will be more color illustrations, the best research reports from universities, more international coverage, better regional reporting, more news, and closer contact with associations. We will continue to build our mail order book program for a central source of turf and tree references. Authors for future references will be sought to help build the information base for the future. The full force of one of the world's biggest publishers is now behind the Green Industries.

Harvest Publishing Company, a subsidiary of HBJ, moved the magazine to New York so that it could reap the full benefit of business magazine publishing expertise. The staff from Harvest has been maintained, which indicates HBJ wants to improve, not diminish the contribution of the magazine. This is not a step toward production line journalism. It is a vote of confidence from a publisher that knows a good audience.

West Coast subscribers will also gain. As of January, we will have a West Coast correspondent to cover the particular needs of the West more fully. Then we plan to grow internationally. It is a big challenge requiring the expertise of an international publisher. Weeds Trees & Turf as a publication of HBJ will be able to grow with the resources it needs and now has.

One of our hopes is to begin publishing letters again from you. Although we have been receiving some extremely insightful mail, lack of space has inhibited our including this in the magazine. Don't think your comments and criticisms have fallen on deaf ears. Send them to me at our new address:

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JOHN DEERE
850

"When our aircraft tug broke down for the last time, we replaced it with something reliable from John Deere."

E. K. Jones, Jr., President,
Iowa City Flying Service, Iowa

If it weren't for E. K. Jones, Jr., and his John Deere 850 Tractor, a lot of airplanes might never get off the ground.

Thirty times a day, he uses his John Deere to pull airplanes out of the hangars.

"It's a real nice tractor, and I haven't had any trouble with it," says Jones, after 1,046 hours of service.

But things weren't always so easy. Until a couple of years ago, he hauled airplanes with an old aircraft tug that gave him nothing but trouble.

"Every time it broke down, we had problems."

Which explains the feature Jones likes most about his John Deere 850 Tractor.

"It's maintenance free."

Small enough, yet big enough.

When his old aircraft tug finally died, Jones needed more than something reliable. He also needed something that was big enough to pull planes as heavy as six or seven thousand pounds. Yet small enough to be economical to buy and operate.

So he bought the 22-PTO-hp John Deere 850.

It has a compact, water-cooled, 3-cylinder diesel engine that has enough power and stamina to pull airplanes around, day in and day out, year after year.

And because it's a diesel, it's more economical to operate. Which is important to Jones because sometimes he runs his tractor all day long, non-stop.

A better tractor, even for pulling airplanes.

The fact that Jones uses a John Deere Tractor to haul airplanes certainly displays its versatility.

And there are some good reasons why people use a John Deere 850 Tractor for so many different things.

It has a well-spaced, 8-speed transmission, and a differential lock. It has a 3-point hitch (Category I), 540-rpm PTO, an adjustable drawbar and a complete line of power-matched equipment. And you have a choice between traction and high-flotation tires as well.

Built to last.

Of course, like all John Deere Tractors, the 850 is built to last.

"The way it's been running, it will probably be running as long as I'm in business," says Jones.

And E. K. Jones, Jr., and the Iowa City Flying Service plan to be in business for a long time.

The fact is, John Deere Diesels are helping lots of people get projects off the ground.

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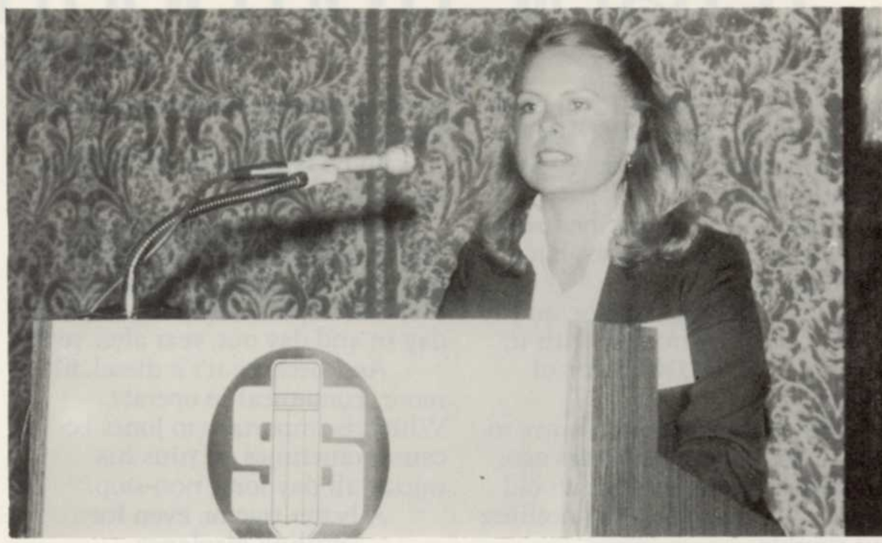
GREEN INDUSTRY NEWS

Interior Landscape conference draws trade exhibitors

For the first time, the recently-formed Interior Landscape Division of ALCA gathered trade exhibitors at its annual conference held Sept. 10-13 at the Fairmont Hotel in Denver.

Major manufacturers and suppliers displayed their products and services for the industry during the four-day meeting. Interior specialists also heard a wide range of topics.

The theme for the conference was "Interior Landscaping: Prospering in an Uncertain Economy" and was carried through all of the many sessions. Gary Luing, dean of the School of Business & Public Administration, Florida Atlantic University, gave the keynote address which focused on "The Current Economic Climate and Its Impact on Interior Landscape Firms."



Laine Craft, president of Living Interiors, Lake Park, FL, was formally installed as chairman of the Interior Landscape Div. of ALCA.

The major portion of the program was devoted to a series of concurrent workshops, including six different topics. Financial consultant E. Gray Payne made two workshop presentations, one on proper accounts and accounting and another on cash flow analysis and budget projections. Personnel administration expert Bill Liley (Colorado State Univ.) worked in another workshop with a panel of interior contractors on current personnel policies and practices in the industry.

Nationally-known John Grogan (Nashville, TN) presented workshops on sales and marketing. The first dealt with techniques of face-to-face sales situations and proven methods of successfully closing. The second delved into promotion and public relations and analyzed the approaches and philosophy of promotional literature.

In addition to the business topics, one workshop was devoted to the technology of the foliage industry, the current state of foliage plant inventories and future trends, new plant diseases and pest problems, and new pesticide treatments.

The International Society of Aboriculture met for the 56th time in Hartford, CT. Newly elected officers are (left to right): John Z. Duling, Muncie, IN, research trust chairman; Gordon S. King, Amherst, MA, past president; Leslie L. Thot, Detroit, MI, vice president; Robert C. McConnell, Philadelphia, PA, president; Robert N. Berlin, Pasadena, CA, president-elect; R. Dan Nelly, Urbana, IL, editor; Ervin C. Bundy, Urbana, IL, executive director.

FERTILIZER

Jordan will reap a Dead Sea harvest

Jordan's Arab Potash Co., operator of a project that will make Jordan a major world supplier of potash, expects to begin supplying world markets by the spring of 1983, reports Chemical Week.

Financing for the $425 million project is split among a number of groups. The U.S. Agency for International Development is supplying $38 million. Another $35 million is coming from the World Bank. The rest is from the Libyan Bank, the Iraqai Fund, the Kuwait Fund, and a special OPEC fund.

In full production, Arab Potash will be turning out 1.5 million tons a year of potash. Some material produced will be sold in the Arab world, but most of it is earmarked for marketers located in France, Japan, and the U.S.

PLANT MANAGEMENT

Contributions sought for new publication

A publication planned by the University of Wisconsin-Madison is seeking news and information on the restoration and management of plant and animal communities for its first issue.

Called *Restoration and Management Notes*, the publication is intended to encourage exchange of up-to-date information between ecologists, land managers naturalists, landscape archi-

Continues on page 10

When Dave Portz renovated 14 fairways with Roundup®, the members played the same day he sprayed.

Dave Portz
Grounds Superintendent
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LANDSCAPE CONTRACTOR NEWS

1981 ALCA Trade Show set for New Orleans

The 1981 ALCA Trade Exhibit in conjunction with the group's annual meeting will be held in the French Market Exhibit Hall of the Hyatt Regency New Orleans on Feb. 10. The theme of the meeting is "Getting the Right Numbers."

The popular industry show will attract roughly 1,000 of the leading commercial landscape contracting firms. Booth space is available on a "first come, first served" basis. Full information and space reservation material is available from: ALCA Exhibit Manager, 1750 Old Meadow Road, McLean VA 22102.

ASLA publishes national directory

The American Society of Landscape Architects has published its *1980 Members' Handbook*, which contains 471 pages of professionals, affiliated services, and award programs.

The list of landscape architects is grouped alphabetically and includes each individual's full address. A second list groups them geographically. The handbook also contains an extensive list of private landscape architecture firms, government agencies and academic institutions, and the address, telephone number, and names of ASLA members in each organization.

Copies are available to schools and libraries for $10 and non-members and other organizations for $40. Send payment to: ASLA Members' Handbook, 1900 M Street N.W., Suite 750H, Washington, DC 20036.

Seattle will host maintenance symposium

Programming at the 1980 ALCA Landscape Maintenance Symposium will be centered around the meeting's theme, "A Framework for Planning and Managing in the '80's," according to program chairman Rod Bailey.

The symposium will be held at the Washington Plaza Hotel, Seattle, WA, on Dec. 1-3. It is designed for owners, managers, and staff of maintenance-oriented businesses who are looking for paths to survival and success in the decade ahead. Sessions will cover markets and services and products and equipment.

For complete information and registration materials, write: ALCA, 1750 Old Meadow Road, McLean, VA 22102.

tects, administrators of conservation agencies and programs, and others concerned about or responsible for ecologically sound approaches to the preservation and management of natural areas.

Notices will be limited to 200 words and may deal with research, field projects, meetings, publications, and other matters related to the active management of the plant and animal communities native to the central and northeastern parts of North America. Deadline for the first issue is Dec. 31, 1980.

Persons interested in contributing or receiving further information should contact: Dr. William Jordan, Editor, The University of Wisconsin-Madison Arboretum, 1207 Seminole Highway, Madison, WI 53711.

TURF

Manufacturer helps support turf program

A new program offered by Midwest Toro of Omaha will benefit turf research at the University of Nebraska Institute of Agriculture and Natural Resources.

Toro is loaning a $9,000 85-inch triplex reel mower to the University for one year. The new mower will enable researchers to relate more closely to the golf and sod production industries which use commercial equipment, according to Bob Shearman, associate professor of horticulture. Until now, home lawn care equipment has been used in the turf research program.

The company's support program was begun this year and is open to U.S. universities with research plots and demonstration areas and a teaching-research-extension program in turf.

CONFERENCE

Lawn & Garden Assn. gathers in Los Angeles

Fifty-five distributor companies and 92 manufacturer companies of the National Lawn & Garden Distributors Association came to the 10th annual convention which was held at the Century Plaza Hotel in Los Angeles.

Howard Jarvis of Proposition 13 fame opened the meeting with a keynote address on "You and Your Taxes." Other speakers discussed making sales and marketing efforts more productive, adapting to future changes, and profiting in spite of inflation.

Retiring President James Beckmann of Turf Products Co., St. Louis, turned over the gavel to newly-elected President Franklin C. Dikeman of M.G.R. Feed Co., Inc., Hammond, IN. Frank Forier of Terminal Sales Corp., Detroit, MI, was elected vice president and George Jarmillo of Las Vegas Fertilizer Co., Las Vegas, NV, was elected secretary-treasurer, of the association.

PESTS

Beetles attracted to bluegrass and sex

Recent tests have found that the Japanese beetle is not only attracted to bluegrass, but it can also be lured into traps by a new sex-attractant bait, says the Ohio Agricultural Research and Development Center in Wooster.

Tests have shown that when two beetle larvae in the underground growth stage were placed in a 6-inch pot of Kentucky bluegrass, they reduced the growth nearly 50 percent by eating the roots away.

When the water supply was limited the damage was much worse, resulting in even less growth or death of the plants.

Research entomologist Michael G. Klein said that USDA researchers have synthesized a material based on an attractant released by female beetles. When the attractant was added to the food baits, it increased the capture of beetles by as much as 800 percent dur-

Continues on page 14

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GOVERNMENT UPDATE

EPA announces pesticide labeling program

The Environmental Protection Agency recently initiated a program to upgrade labels of pesticide products that provides instructions for their proper use and information on their hazards.

The EPA has designed the Label Improvement Program to enable the Agency to respond rapidly to labeling needs identified within the Agency and by the industry, the users, and the public. This program will also provide for needed uniformity in compliance and enforcement activities.

The Agency will require that registrants amend their registrations to modify their labels in certain ways within reasonable time frames to be established.

For further information, contact Jean Frane, Registration Div. (TS767), Office of Pesticide Programs, EPA, 401 M St. S.W., Washington, D.C. 20460, 202/426-2510.

USDA uses parasites against gypsy moths

Nine species of parasitic flies and wasps are helping the U.S. Department of Agriculture and state agencies wage biological war against the gypsy moth in infested areas of the Northeast.

The parasite lays its eggs in or on the moth's eggs, caterpillars, or pupae. Later, a fly maggot hatches and feeds on the caterpillar, eventually killing it. Some parasites attack only gypsy moths; others also attack other destructive caterpillars.

A pilot project, conducted by the Pennsylvania Department of Environmental Resources with USDA assistance, is underway in a Pennsylvania state park. Gypsy moth experts will survey plots intensively every year and apply light doses of chemical or biological insecticides only when infestations are at a critical level.

According to Stanley McNally, a USDA area director and coordinator, "This is the role we see for parasites—not a replacement for pesticides but one of a variety of tools that can reduce gypsy moth damage within the infested area while allowing pesticides to be used less often."

Bergland cites boost in ethanol production

Secretary of Agriculture Bob Bergland thinks President Carter's goal of producing 500 million gallons of alcohol fuels during 1981 is reachable through a combination of factors.

"These factors include the provision of Federal tax incentives for a substantial portion of the amortized life of a plant (through 1992), continuing increases in the real price of petroleum and gasoline, some clarification of regulatory policies involving the manufacture and use of fuel ethanol, and marked reductions in the cost of debt capital," he said.

Bergland said there are two areas for which the Department of Agriculture has primary responsibility in supporting and accommodating ethanol production. These are:

1. Managing the agricultural programs and policies for which USDA has primary responsibility with sensitivity to the requirements of fuel ethanol plants for farm-produced feedstocks, and reduction of any adverse impacts on the agricultural sector and the economy generally; and
2. Use of the established state and local credit processing and servicing system of USDA to provide loan assistance for expanded distillation capacity to meet the President's production goal.

"In addition," Bergland said, "the USDA in cooperation with the Department of Energy is expanding research and testing activities to find alternative crop and forestry feedstocks for ethanol production (including cellulosic feedstocks), and to improve conversion technologies enabling the use of cellulosic and other alternate feedstocks."

ing the height of the breeding season.

The tests also found that the male beetles were more attracted by the sex attractant early in the season and by the food attractants later. However, the two kinds of attractants are more effective combined than when used separately, said Klein.

ARBORISTS

Ohio ISA to sponsor arborist foreman show

The special needs of arborist foremen will be the subject of a day-long seminar at the Agricultural Technical Institute in Wooster, OH, on Dec. 6.

Extension horticulturist Fred Buscher, NAA Executive Director Bob Felix, and other tree experts will cover responsibility and management of all areas of arboriculture. The session will run from 10 a.m. to 4 p.m.

Preregistration is strongly advised. Contact Fred Buscher, OARDC, Wooster, OH 44691, 216/262-8176. Lunch is provided to those who preregister.

SEMINAR

Arborists plan talks on tree injuries

The National Arborist Association will hold its 6th annual technical seminar on Dec. 9-10 concerning "non-parasitic injuries to trees."

Dr. Terry Tatter, associate professor of plant pathology at the Shade Tree Laboratory, University of Massachusetts, will present the program at the Hyatt Regency O'Hare in Chicago. It will cover environmental stress, people pressure, and the interaction between infectious and non-infectious diseases of trees.

For further information, contact: National Arborist Association, 3537 Stratford Road, Wantagh, NY 11793.

PROMOTION

Frazier named pres of Simplicity Mfg.

Jacques F. Trevillyan, executive vice president of Allis-Chalmers Corp., announced that Warner C. Frazier of Glendale, WI, has been named president of the Simplicity Manufacturing Co., an Allis-Chalmers Co.

Frazier, previously vice president, marketing, has been with Allis-Chalmers since 1955. He also served in engineering application and sales promotion posts in various divisions, as merchandising manager for the Industrial Truck division, and manager of the Material Handling Sales & Service operation.

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Powered by a tough 8-hp engine, the Greensaire II takes a full 24" swath and lets you aerate up to 8,000 square feet per hour. And, with four sizes of interchangeable tines, you can achieve precisely the amount of aeration your greens need.

What's more, by attaching the optional Core Processor, you can separate and collect the thatch, and return the soil as top dressing—all in one operation.

For the same precision in a smaller size, choose the self-propelled Greensaire 16. It offers the same choice of tine sizes, and can aerate up to 4,000 square feet per hour.

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TRAGEDY OF DUTCH ELM DISEASE BEARS HOPE FOR MODERN CONTROL

By John L. Hart

The stately American elm *(Ulmus americana)* is still very much a part of our forests, parklands, and urban plantings. While millions of these exceptional trees have fallen to Dutch elm disease, many millions more are still living. There are large areas in the East where it has ravaged, leaving behind a small, heavily protected population; there are other large areas where it rages; and still other areas, principally in the West, where the disease has not yet entered. The elm is still very much a concern of most grounds managers, both financially and emotionally.

The popularity of the American elm as a shade tree is almost legend: it is hardy vigorous over a wide span of latitude and climate, with a native range blanketing all of North America east of the Rockies; it tolerates soils from sand to swamp; it is long-lived (typically 100 to 150 years), providing excellent shade for most of those years; its "vase" or "umbrella" form is a vegetative classic; it resists pollution; and until Dutch elm disease arrived around 1930, it was not readily susceptible to insects or disease. For good reason, the American elm is the most widely planted tree in the US, and concerted efforts to rescue this species from the fate of the American chestnut continue.

The Deadly Disease

Dutch elm disease was first described in 1919 in the Netherlands, hence its nominal reference to the Dutch. The probability is that the blight entered Holland via Asian ships during the First World War: both the Chinese and Siberian elms *U. parvifolia and U. pumila)* show great resistance to the disease, indicating a long mutual evolution in Asia. The spread across the continent was rapid, and by the end of one decade the disease was present throughout Western Europe and England.

The first positive diagnosis in the US was in June of 1930, with a total of five elms affected in Cleveland and Cincinnati, Ohio—source of disease unknown. This outbreak was controlled by the rapid destruction of the diseased trees, but three years later the disease was reported throughout northeastern New Jersey, in New York City, and in the Westchester area. Then in August of 1933 both the disease and the European elm bark beetle were found in a shipment of elm burls from Europe; further checks proved that numerous shipments were contaminated, destined for locations throughout the East and South. Such importations were presumed to be the source of the disease's entry into the US.

Since that time the story has been a tragic one. All of the elm species commonly planted as shade trees in the US are susceptible, but the American elm—the most highly valued and most widely planted — is also the most susceptible. Dutch elm disease—or DED, a chillingly appropriate acronym — has swept across the country like a prairie fire, leaving six-foot-diameter stumps, barren city streets, and broken budgets in its devastating swath. In 1933 there were fewer than 1,000 fatalities, in 1934 almost 7,000 and by 1936 there had been more than one million removals. At that time the disease was reported to be contained within a fifty-mile radius of New York City. By 1949, less than fifteen years later, DED extended from New England west to Indiana and south to Virginia and Tennessee, with an isolated outbreak in Colorado. And twenty years thereafter, DED had spread to 41 of the 48 contiguous states. By the early 1970's it had leaped the barrier of the Rockies into California and Oregon. At least in part, the elm story is a tragic example of being swamped by success: the elm's overwhelming popularity lead to a virtual monoculture—the perfect habitat for epidemic.

But population density doesn't explain it all. DED is an especially mobile and efficient killer. The disease itself is actually a fungus, *Ceratocystis ulmi.* The most common and effective vector which transmits this fungus in the US is the European elm bark beetle *(Scolytus multistriatus).* The bark beetle is capable of flying for several miles, which gives the disease considerable mobility. Since the beetle is also elm-specific (to all US species), the disease often reaches its target. This border insect typically feeds in the small branches and twigs of the tree crown; it lays eggs beneath the bark by tunneling through to the sapwood, particularly in weak, dying or dead trees. If the beetle carries fungal spores and if it penetrates the bark while feeding or breeding, DED may be introduced.

Once in the tree tissue the fungus can grow rapidly by extending its rootlets (hyphae) into the cambium and wood. When it penetrates the large vessels of spring wood, it produces spores which are carried through the tree in the flow of sap. Accompanying this invasion are the characteristic symptoms of DED, usually appearing from late spring to mid-summer: wilting, yellowing, and/or dropping of leaves; gray-brown staining of the last annual ring of sapwood just beneath the bark; the spreading of these symptoms progressively through the tree; and — within days or months or occasionally years, depending on the virulence of the fungal strain and the health and genetic resistance of the particular elm—death. Death has been attributed to toxins produced by the fungus, and/or to simple mechanical plugging of the water vessels, killing by dehydration. It appears that the presence of DED triggers the tree to produce gums or resins in an attempt to isolate the infection. These self-generated materials and their clogging of the vessels, rather than the fungus itself, may be the final cause of death.

The fungus can continue to grow and produce spores saprophytically after the tree dies, and the beetles prefer the dead or dying tree for breeding— which means the rapid multiplication of fungus-carrying vectors. In a typical annual life-cycle, eggs laid in the early fall by a spore-laden beetle (or by a "clean" beetle in an infected tree) will give rise to many DED-carrying, first-generation adults the following spring. Each of these will infect new elms while feeding, then will breed and lay eggs for a second vector generation to emerge as adults during early summer. This new and geometrically larger generation will feed, infect, and breed, creating a third generation by late summer. Eggs produced by this new population will overwinter as larvae under the bark, providing a new cycle for the next spring (see Figure 1). To give an over-simplified example of the European elm bark beetle's population growth, two late-summer beetles giving rise to fifty adults the next spring could lead to almost one million eggs the following winter.

The elm bark beetle as a vector is indeed a model of efficiency and effectiveness. To make matters worse, there are other models: DED can be transmitted by root grafts between neighboring elms—an especially dangerous situation in a closely planted park or boulevard; other bark borers are either known or suspected to be additional insect vectors; and there is evidence that DED can be spread by rainwater, wind, birds, pruning tools — basically any method of bringing DED in contact with a tree wound. The bottom line of this plague is an estimated death rate of one-half to one million American elms per year. At the height of infection in an uncontrolled urban area, mortality may surpass twenty percent of the total population each year.

Prevention, Treatment, Cure

Faced with the high mobility and high toxicity of DED, it became clear in the 1930's that an epidemic rivalling the Chestnut blight was underway. The quest for control methods began quickly—a quest which still continues today. And while new cures are announced with some regularity, so far none has proven both safe and effective, much less economical. The search for a solution has focussed on three areas: insect vector control, control of the fungus itself, and—throwing in the towel—genetic selection for a new elm which possesses the many positive characters of *Ulmus americana* and in addition shows high resistance to DED.

Sanitation. From the first it was obvious that destruction of bark beetle breeding sites was critical in any effort to slow and curb the spread of DED. This treatment was pioneered in the 1920's in Europe, with fair success. Since weak, infected, dying, and dead elm trees are a prime site of breeding, and since new hatches may occur through the summer in addition to the overwintering population, immediate removal and destruction of the trees is required, often by state or local law. This process should include removal of *any* elm in an unhealthy condition: weak, wounded, storm-damaged, sickly, old and ailing, etc. It should also include periodic removal of natural dieback, approximately on a five-year cycle.

In many communities the deadwood is either buried at a landfill site or burned. The former method is a high expense, may lead to the eventual collapse of the site as the wood decays, and is a waste of a natural resource; the latter also wastes wood, and moreover adds particulate matter to the air—it is therefore illegal. In some areas the trees are sold as firewood or saw-logs (e.g., for rough-cut pallets), and in other areas they are chipped for use in landscaping, animal husbandry, etc. If so utilized, mid-summer fatalities should be used immediately, and late-summer fatalities before the spring hatch; otherwise, they will continue to contribute to the DED problem by supplying new hatches of infected beetles to the area. If the trees must be left standing due to large population size or difficulty of rapid removal, either an agent lethal to the beetles (from eggs to adults) must be applied, or the trees must be mechanically or chemically de-barked. Chemical de-barking with cacodylic acid has recently received EPA registration and is the procedure currently recommended. The compound is applied through cuts in the bole during the tree's last stages of life; the sap distributes the acid through the tree, which then dries out, shrinks, and sheds its bark.

Early investigators also noted that DED often traveled between closely planted elms via root grafts connecting the vessels of adjacent trees. In a dense population such grafts may connect essentially all trees together. Hence another of the first sanitary recommendations was to sever the roots between a diseased and a healthy tree. (A general rule of thumb is that the distance that roots extend outward from the trunk equals the height of the tree.) Trenching to a depth of 24 inches in the area of root overlap is usually sufficient. For additional protection, a second barrier may be placed beyond the adjacent healthy elm, thus isolating it also from its neighbor(s) in the event it is infected but does not yet show symptoms. Such trenches may be backfilled immediately and the diseased tree then removed. Trenching must precede removal; otherwise diseased sap may be pulled from the severed tree into adjacent healthy trees.

In the past decade chemical soil fumigants (e.g.,

The deadly disease has swept through American elms like wildfire since the 1930's when it hit the continent via shipments of elm burls from Europe. Early symptoms of the fungus appear in wilting and yellowing of the leaves.

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Vapam, VPM) have been used increasingly to sever root grafts. One-inch by 24-inch holes, six to 12 inches apart, are drilled in the root overlap zone, the chemical solution is poured in, and the holes are sealed. Since action is not immediate, two weeks should be allowed between treatment and tree removal to avoid backflow of diseased sap into the healthy trees. A cautionary note: such fumigants are non-specific in action and should be used sparingly and with the utmost care, strictly following label directions. Turf will be killed in a 12-inch strip along the line of application, and spills can be disastrous; use near ornamentals should be avoided.

Isolation of diseased trees by severing root grafts remains a recommended practice where elms are densely planted. It has been shown to be an effective method of preventing the rapid loss of an entire population, and should be included in any good program of sanitation.

One additional recommendation regarding sanitation is the thorough cleansing, in alcohol, of all pruning equipment, saws, chisels, drills, and other tools used on elm trees. The DED fungus enters the tree through wounds: one spore carried on a pruning saw may be sufficient to infect a tree and lead to its death.

A number of studies have been undertaken to evaluate the impact of sanitation on DED's spread. After thirteen years of good sanitation in Syracuse, NY, elm losses amounted to thirteen percent of the initial population. In a study of a number of localities in Illinois, communities practicing only sanitation showed mean mortality of four percent annually over more than a decade; comparable communities without such cleanup lost 80 percent to 95 percent of their original elm population in little more than ten years. In Fredericton, New Brunswick, fifteen years of careful sanitation have resulted in only five percent loss (less than one-half of one percent per year); in neighboring, uncontrolled areas, an average of sixty percent of the initial elm populations has died (up to fifteen percent per year). In short, strict sanitation often reduces elm mortality to less than two percent per year; without sanitation, the disease may claim 10 to 20 percent per year.

The sanitation strategies enumerated above, aimed at slowing the increase and migration of the bark beetle populations, and at preventing root or mechanical transmission of the disease, were the first control measures recommended. They remain the most vital part of the battle against DED. Unfortunately, fortunately, communities which practice strict sanitation and follow all recommendations are too rare. Those few which do, however, have shown marked reductions in DED mortality. It is certainly not an ultimate solution: both species of bark beetle can breed in all elm species grown in the US; further, an urban effort to clean up will not affect the neighboring rural areas where dead elms often remain standing for years. So while a strict sanitation program will not bring the disease to a complete halt, it will greatly decrease the rate of death, thus allowing sound planning, long-term budgeting, a headstart on replacement—and perhaps the time necessary for a satisfactory cure to be developed.

Insecticides. The chemical war against the disease began seriously with the advent of the insecticide DDT. First formulated in the late 19th century, DDT was not used as an insecticide until 1939, with commercial applications not gaining momentum until after the Second World War. In the late 1940's and throughout the 1950's, its deployment mushroomed. For control of the insect vectors of Dutch elm disease, this chlorinated hydrocarbon was used extensively by communities, public agencies, and private arborists for almost thirty years. Along with sanitation, DDT remained the principal recommended control until Carson's *Silent Spring* alerted the public to the chemical's dangerous characteristics: high and broad toxicity, mobility in the environment, long life, and ability to move up the food chain at increasing concentrations. (To drive the latter points home, there are indications that DDT, or any broad-spectrum insecticide, may actually favor the target insect by removing all natural controls on it; that DDT damage to avian, aquatic, land, and soil life is still being felt; and indeed that while DDT was banned almost totally in 1972, its concentration in human tissue, if the ban remains in effect, is projected to peak in the 1990's.)

When the more treacherous effects of DDT began to surface in the 1950's, other organic compounds began to be phased slowly into the chemical warfare arsenal as DDT was phased out. One of the most widely used and recommended in the 1960's and through the 1970's was methoxychlor, a close relative of DDT. Although considered safer than DDT, methoxychlor is nonetheless poisonous to birds, fish, mammals, and a broad spectrum of insects. It should be used discriminately and with caution, if at all.

Perhaps the most enlightening fact here is that good sanitation alone has been shown to reduce annual elm mortality to less than one percent in certain cases; the insecticides, at some expense in material, labor, and equipment, do not greatly improve this rate. Indeed, in the previously cited study on communities in Illinois, there was no statistical difference in elm mortality rates between communities using sanitation alone and those using both sanitation and methoxychlor. In addition to the high and recurring expense, the broad spectrum of toxicity, and in some cases persistence and mobility, insecticides for DED control are unable to ensure a 100 percent kill of the bark beetle. One beetle carrying one spore can fell, with several nibbles, a six-foot-diameter tree. In light of the above, use of insecticides to prevent DED seems a risky investment at best. If the fullest protection program is desired — e.g., to preserve a particularly venerable, historic, or in some other way an especially valuable elm—better approaches are now available, as noted below. Finally a spraying program cannot replace good sanitary practices: sanitation remains the most vital control program and the highest priority in the battle against DED.

Biological Control of Insects. For a number of years, researchers have been investigating other, more biological means to control the fungus-carrying insects. Possible biocontrols might include insect attractants, repellants, release of sterilized males, and introduction of disease or predators. A few such methods have been tried.

Attractants which have been developed include elm bark extract and bark beetle pheromones: a trap is baited with one or the other (food or sex!), and the beetles thereby lured into the trap are killed. One pheromone in particular, which stimulates both sexes to amass for breeding and feeding, has been tested but has not yet received EPA registration. There are indications that such attractants may be self-defeating,

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serving only to attract more beetles into the area.

The opposite pole of beetle repellants is being investigated, in particular by Dr. Dale Norris of the University of Wisconsin. Preliminary results indicate this to be a promising avenue of research. Testing continues.

And a symbiont of bark beetle eggs, the tiny wasp *Dendrosoter protuberans*, was introduced into the US from France in the late 1960's. Thousands were bred and released with the hope that the wasp would become established and spread, helping control the bark beetle population. Results have been disheartening. Problems with the wasp are that it is not effective on thickbarked trees, it does not usually attack the native beetle, and it may not survive in the northern US.

As in the case of sanitation and insecticides, these biological controls and others like them can help slow the continental sweep of DED; they will not ultimately solve the problem or cure the disease. But as retardants they may prove to be valuable, helping reduce the beetle population to more manageable levels. Such methods of control have worked in the past to an appreciable degree in management of the gypsy moth, citrus scale, Japanese beetle, and other insects viewed as pests. Further, if properly researched and planned, biological controls are more ecologically preferrable and less expensive over the long term than the more artificial methods such as insecticides. Pursuit of an effective biocontrol agent should be a primary path for DED research.

Fungicides. A more direct approach than an attack on the insect vectors of DED is an attack on the disease itself, *C. ulmi*. Much current research is being done in the area of fungicides. The ideal DED fungicide would exhibit several characteristics: specificity and high toxicity for the fungus; non-toxicity elsewhere in the environment — including the tree itself, ability to incorporate into and distribute throughout the tree, immunizing all parts of the tree against infection; persistence in the elms and persistence of virulence to the fungus, not requiring frequent renewals; and practicality, ease of application, and economy.

The first such "cure" was the garden fungicide Benomyl (marketed as Benlate), approved in 1972 for restricted use on elms as a DED preventative. The hope was to kill the fungus when it first came into contact with the tree. An early summer spray application of Benlate, often combined with a dormany spray of methoxychlor, achieved sporadic success. Benlate was used less successfully as a soil treatment, relying on root uptake to distribute it throughout the tree. Both methods of application were preventative rather than curative in intent, and neither could ensure complete coverage and protection. Meanwhile, a further refinement was being tested: injection of the chemical directly into the tree, a process which was hoped to be the long-sought ideal solution.

Injection is not a new idea. It has been traced at least as far back in history as Leonardo da Vinci, who bored holes in peach trees and injected arsenic into the rising sap to determine if the treatment would produce poisonous peaches. (It did.) There are other reports of similar injection experiments in the 18th, 19th, and 20th Centuries. At its simplest, the chemical injection process relies on the natural pressure of transpiration to pick up the chemical extremities of the tree. Benlate in theory would kill the DED fungus on contact with the protected wood. The principal problem was in getting a sufficiently high concentration of the chemical in all portions of the tree.

Drilling holes at 6-inch intervals around the lower trunk helps ensure even distribution throughout the tree. A pressurized solution of Lignasan is injected through the nozzles, which are connected by tubing to a pressure tank. The process can be time-consuming, costly, and ineffective against some strains of DED.

The natural pressure of transpiration was then supplemented with positive injection. The Elm Research Institute, a non-profit organization in Harrisville, NH, made this process widely accessible through the publicizing and marketing of a low-pressure tank injection system. With little financial outlay, a two-foot-diameter elm could be treated in as little as thirty or forty minutes on a good day. Unfortunately Benlate was not highly soluble in water—highly insoluble in some water—often resulting in low uptake of the chemical even under pressure: it either did not reach all parts of the tree, or did not reach the extremities in a suitable toxic concentration. Once again, success was limited.

It was not long, however, before a more soluble form of Benlate's active ingredient was developed. Hailed more than ever before as the miracle cure, Lignasan BLP was cleared for use in 1976. It is still in use today. Research originally indicated that Lignasan met several of the requisites for miracle-cure status: it appeared to be fairly specific and toxic for DED and relatively harmless to other organisms and to elms; injection around the circumference of the tree was thought to give the chemical thorough distribution in the tree; and the cost of the chemical itself was usually below ten dollars per tree.

Since the initial glowing reports, Lignasan has become simply a good method — preferable to spraying for beetles—for helping slow the spread of DED and for increasing the protection of selected elms. Typically, holes are drilled at six-inch intervals around the lower trunk, either into the root flares or into the excavated roots themselves: this helps ensure distribution and protection throughout the tree. Holes should preferably be shallow, into the outer two or three growth rings (indicated by white shavings): this creates a smaller wound and gives better distribution of the chemical than deep holes. Nozzles, connected by tubing to a pressure tank, are then secured in the holes and the pressurized solution of Lignasan is injected, a process requiring fifteen minutes to several hours depending on a large number of soil, tree, and weather factors.

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Sure, there's more to maintaining quality, disease-free turfgrass than a couple of fertilizer applications. But turfgrass scientists across the country are reporting that a fall application of IBDU (31-0-0) can produce turfgrass with better root development and less disease problems.

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Lignasan is labelled for two rates of application: preventative and therapeutic, the latter at twice the preventative dosage. Research indicates that the higher therapeutic dosage gives better distribution and a higher level of disease protection; increases beyond that do not appear to give added protection. Although some studies indicate that the therapeutic dosage will protect the tree for two years or more, the current recommendation is to inject annually.

Negative aspects of the above process include the need for repeated applications, which not only damages the pocketbook but also may lead to expanding injury to the tree; the somewhat complicated and time-consuming procedure involved, particularly when treating a large number of trees; the need to inject during a rather short time in the spring, which is next to impossible in a large population; the necessity, rarely realized, to achieve complete distribution in the tree; and the fact that some strains of DED appear to be resistant to Lignasan.

More research is needed on techniques for achieving optimal distribution of the fungicide in the tree, on alternative methods which will reduce the severity of tree wounding, and on the chemicals themselves, to make them sufficiently toxic to the specific fungus yet safe to the tree and other organisms, and to provide a period of protection longer than one year.

Lignasan (or similar products variously marketed as Elmosan, Ulmasan, Noculate, Arboral Fungicide, Correx, Elmpro, and Arbotect 20S) certainly carries no guarantee for DED prevention, much less cure. Research and use in the field indicate it can, if properly applied, lower the statistical incidence of DED infection. In some cases, particularly in smaller trees, it can stop the progress of DED when infection is minimal (five percent or less of the crown) and when injection is followed in ten days by sanitary pruning. When infection has spread beyond a small isolated branch, or when the disease is contracted through root graft, or when the tree is large, a cure is highly unlikely.

Certainly these fungicides should be considered in a strong control program—but effectiveness and cost are considerations too. Perhaps its best use is as a substitute for broadcast spraying in individuals or small populations of highest priority. Lignasan can be a preventative, sometimes a cure, but unfortunately it is no miracle. And it is most emphatically not a substitute for good sanitation.

Other Treatments. Like cancer and its many miracle cures, the DED epidemic has spawned many strange recommendations, from painting the elm trunk with used motor oil to pounding galvanized nails at intervals around the circumference, and from vascular injections of antibiotics to vascular injections of turpentine. A large compost pit dug at the base of the elm and filled with worms is perhaps the most earthy. None of these has been shown to be effective.

Fertilizer application has been recommended occasionally in an effort to strengthen the tree, but recent studies indicate excessive fertilization may actually aid the disease by enlarging the vessel size, thereby making the tree more susceptible rather than more resistant to DED.

Breeding. The search for an American elm resistant to DED, and attempts to create a hybrid elm possessing both resistance and the many excellent growth qualities of the American elm, have been going on for forty years. These efforts have just begun producing elms for the market.

A small number of American elms which show above-average DED resistance have been located or selected. Attempts to breed or clone them give hope of preserving the pure species. One notable example among several—and indicative of the time needed and problems encountered—is the research at Cornell University. Since the early 1930's they have been running trials on 21,000 American elm seedlings, periodically infecting each individual with an innoculum of the fungus, and culling those which fail the test. After approximately forty years of testing, sixteen trees remained in 1974. Each has been innoculated with a variety of fungal strains at least seven times in five separate years, including three successive years. In each case innoculation initially led to DED symptoms, but this was followed by remission of symptoms. Quite simply, the elms resist the disease. The mechanism of resistance was attributed to compartmentalization of the infection and to subnormal dimensions of the wood vessels. The resistant trees typically had slower growth rates than normal.

These sixteen elms have been closed, bred with each other, and bred with resistant elms from studies elsewhere. Unfortunately—and oddly—neither progeny nor clones appear to have the resistance of the parents. It is hypothesized that longer studies of the second generation are needed, coupled with less severe early culling—that resistance may increase over time in the seedlings.

Given the remarkably high susceptibility of the American elm, the large variation in the fungus, and the decades needed for selection in large woody plants, these less-than-ideal results are not surprising. Efforts continue, and the hope remains that the selection program will, quite literally, bear fruit.

Development of a resistant hybrid (American elm crossed with a more resistant elm species) is more promising at this time. Many crosses have been and are being made, with particular emphasis on hybridizing the American and Siberian elms *(U. americana X U. pumila)*. None has been released, but researchers are guardedly optimistic.

The most widely publicized hybrid has been the 'Urban Elm,' developed over the last 25 years and made available to the public in the late 1970's. Actually 'Urban' has no American elm sap in it, being rather a cross between the Siberian elm and a Netherlands hybrid. *U. pumils X (U. hollandia* var. *vegetata X U. carpinifolia)*. Reports indicate it will be a good city tree—fast-growing, hardy, resistant to pollution and DED, and adaptable to many soils and climates. It is not, of course, *Ulmus american;* in comparison to the American elm, 'Urban' is shorter and has upright branches, lacking the classic highly prized umbrella shape.

New elms for landscaping and parks are being developed, but it is definitely a long-term project, taking decades. Thus far, the ideal combination of DED resistance and American elm growth and habit has not been found. And in a real sense it is a last-ditch effort, predicated on the continued decimation of the current elm population. Indeed, it is painful to replace a massive, century-old elm with a one-inch sapling.

Nonetheless, this approach may prove over the long term to be the most valuable, given the efficacy of DED and the unreliability of all current treatments.

Current Recommendations

In 1936 *The Garden Dictionary*, a massive compendium of information on cultivated plants, stated in reference to elms and DED: "Prompt eradication and destruction of affected trees is the only known method of control." Today, more than forty years later, thorough sanitation remains the most safe and effective preventative yet developed. To achieve additional protection for selected trees, rigorous sanitation can be used in combination with other of the treatments noted above—most preferrably, systemic fungicides.

The soundest and safest DED prevention program at this time would include the following practices:

1. Periodic *pruning* of natural dieback, and removal of unhealthy, injured, or weak elms, in order to destroy preferred beetle breeding sites. This should be done every four to six years.

2. Frequent (preferrably weekly) *inspections* of area elms for symptoms of DED during the growing season.

3. Annual spring root or root-flare *injection* of Lignasan (or similar product) at therapeutic dosage, per label instructions.

4. Immediate *sampling* for presence of *Ceratocystis* fungus upon noting symptoms of DED. Many communities have their own testing centers; if not, state universities or county extension facilities are available. You can perform the tests yourself at little outlay of money and with little training.

5. Upon confirmation of DED, immediate *injection* of Lignasan at therapeutic dosage, per label. However, if symptoms are noted in more than five percent of the tree crown, or if the entry of DED is via root graft, immediate isolation, removal, and destruction of the tree is indicated.

6. Immediate *isolation* of the diseased tree by cutting all possible root grafts between the infected elm and neighboring elms. The recommended method for severing such grafts is trenching to a depth of two feet in the area of root overlap. Careful and judicious use of a chemical soil fumigant is an alternative to trenching.

7. Ten days following therapeutic injection and root isolation, *pruning* of diseased branches. Studies indicate this should be severe, ten to fifteen feet beyond the signs of infection (wilting and yellowing of leaves, dark staining of wood.) All tools used in pruning or removal should be cleaned in alcohol after use.

8. Immediate *removal* and destruction of the elm if, despite the above efforts, DED persists and progresses through the tree. If symptoms are present in more than five percent of the crown, or if symptoms indicate root-graft infection, remove. Again, tools should be thoroughly cleaned after use. If the tree cannot be quickly removed, chemical debarking by cacodylic acid is indicated.

9. In the midst of treatment and removal, consider anticipatory *replacement*. Designing a new landscape plan and beginning to implement it, assuming an elm disaster, will ensure a smooth transition to established, growing trees rather than the possible sudden shock of a vast wasteland. Needless to say, use a variety of species, with none comprising more than ten percent of the total.

10. Along with all the above, and of equal importance, *educating* your neighbors and the public. Local and state governments must have strict regulations for removal and destruction of diseased elms, and the regulations must be enforced. The most preferrable method of enforcement is knowledge: people must understand the personal and community value of sanitation and the high cost of failure to practice it. Information on DED and on regulations must be distributed and re-distributed. Any number of community projects will further this effort (e.g., incentive programs, clean-up days, free detection labs).

This complete program—excepting Steps 3 and 5 (Lignasan)—should be adhered to for each elm under your jurisdiction. Lignasan injection, if that is determined to be an option, should be reserved for selected individual trees: the elms must be ranked in order of importance and value (aesthetic, historical, age, health, location, etc.), and then grouped into treatment classes—highly valued elms receiving preventative and/or therapeutic injections, and elms of lower value receiving weekly inspection and, upon infection, prompt pruning, isolation and removal. Accurate and detailed records should be kept on all elms in the grounds manager's domain: a number or code for each tree; data on location, size, inspections, prunings, injections, and other treatments; dates of DED detection, trenching or Vapam use, tree and stump removal, site repair, etc.; and costs of all the above. This is not overly time-consuming and is a necessary part of the battle.

And the battle does go on. It has been estimated that by 1930, 77 million American elms had been planted in urban areas; of these, approximately 30 million remain today. On the negative side, after almost fifty years of research, there is no absolutely reliable preventative or cure or satisfactory replacement. However, room for optimism remains. The total US elm population may approach one billion. New treatments are being tested continually, from systemic fungicides to more natural biological controls. Plant breeders strive for a statuesque but disease-resistant American elm variety or hybrid. Meanwhile, the urban areas which have practiced rigorous sanitation have shown remarkably low mortality—low enough to suggest many more decades beneath the shade of the mighty American elm. Even in New England, where the disease has been present for fifty years, many elms survive: as the elm population is reduced, the vector population is reduced and the rate of new infections decreases. Extinction is definitely not in the immediate future of *Ulmus Americana*.

To return to an equally famous "extinction" case cited earlier, the American chestnut may stage a comeback in the near future. Long considered exterminated as a species following importation of the chestnut blight, recent field surveys have located one hundred mature (flowering) individuals in scattered portions in New York alone. In addition, a new strain of fungus has developed, not only less virulent but capable of neutralizing the virulence of the original strain. Not only will a chestnut tree survive and grow when infected with the new strain, but the new strain actually replaces the virulent strain in a previously infected tree. Thus, the outlook for the return of the American chestnut is encouraging.

Let's not give up on the American elm just yet.

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Turfgrass Pathology

Turfgrass Pathology

Houston B. Couch

Internationally recognized turfgrass pathologist Houston B. Couch of Virginia Polytechnic Institute, Blacksburg, takes charge of the pen for this part of the Turf Management Series. Dr. Couch wrote the following history for the Turfgrass Disease Symposium held in Columbus, Ohio, in 1979. The proceedings of the seminar will soon be available in book form from Harcourt Brace Jovanovich, Inc., Book Department, One East First Street, Duluth, Minnesota 55802.

Disease on fine turf has been a major problem since the late 19th Century. Piper and Oakley broadly termed most symptoms as "Brown Patch." Monteith took this information and refined it further. Today, the identity of many diseases is still less than exact. There are arguments over terminology and nomenclature. But much more is known and a great portion of damage by turf disease has been prevented through resistant turfgrass cultivars and maintenance practices.

Knowledge of turfgrass disease will play a vital role in integrated pest management in the future. Relationships between disease and maintenance practices will be clarified. Effects of herbicides, aerification, soil pH, insects, and traffic on turfgrass will be better understood.

Certainly, a basic level of information on turfgrass pathology is vital for the manager of any fine turf area.

Bruce F. Shank

Bruce F. Shank, Editor

PAST, PRESENT & FUTURE

Dusting a putting green *in 1922 with Bordeaux mixture for disease control. This was the first fungicide in general use for controlling turfgrass diseases on golf courses.*

In its fullest sense, turfgrass pathology is an integration of the concepts and principles of the science of plant pathology with those of the practice of turfgrass culture. Consequently, the level of understanding of the nature and control of turfgrass diseases at any point in time is a direct reflection of the extent of knowledge in these two areas of activity, and the degree of skill that has been employed in bringing this information together.

The Past

In Europe, lawns of pure stands of grass were first purposely established in the thirteenth century. It was during this time that the game of "bowls" became popular. The original bowling green was the forerunner of the modern golf course green. Near the close of this century, "club ball", an early form of crickett, came into being.

By the sixteenth and seventeenth centuries, gardens had become more elaborate. Also, more care was being taken in the establishment of bowling greens. In Northern Europe, lawns had become fairly common features of home grounds and village squares. Most towns had a turfed "common" or "green". A form of soccer was being played on these public greens. The height of the grass in these areas was maintained at a low level by the grazing of sheep and goats.

During this same time period, the concepts and practices related to the development and control of diseases of plants were also in a primitive state. The autogenic concept of disease was the order of the day. This was an outgrowth of the theory of spontaneous generation. Its view of disease causality held that maladies of plants were due to internal disturbances, and that the fungi found in association with these disorders were the product, not the cause, of the diseases in question.

Certain inventions and discoveries of this period contributed materially to efforts directed toward mounting a successful challenge to the autogenic concept of disease causality. Among these was the development of the compound microscope in 1590. Improvements were made in the microscope in 1665, and there followed within the next 25 years a series of studies that laid the foundations needed for the progressive and systematic study of plant anatomy and the establishment of the science of microbiology.

With the advent of the eighteenth century, specific biological evidence for the disproof of autogenesis began to accumulate at a more rapid pace. In 1705, the view was expressed that fungi reproduced by developing spores. As the century progressed, the concept that fungi are autonomous organisms was reinforced by a succession of studies and observations. By 1785, the evidence that they were indeed distinct biotic entities in their own right had been well established.

The information that had been gained in the eighteenth century relative to the nature of fungi found direct application in the development of an expanded concept of disease in the nineteenth century. In 1807, the first report giving clear evidence that fungus spores could germinate and infect a plant was published. With this, the allogenic view of disease causality was given a firm, scientific base. Allogenesis perceives disease as being engendered by forces from without the plant, rather than from within. Through its applications, research on the nature and control of plant disease was placed on the proper course. While it would still be some 50 years before the total weight of evidence in support of this concept would finally reduce the voices of the advocates of autogenesis to a faint whisper in the scientific community, the stage had now been set for the development of the science of plant pathology.

During the eighteenth century, turf maintenance became more sophisticated. Instructions for the proper care of grass walks and bowling greens called for them to be rolled and mowed every 15 days. Many of the gardening books of this period contained instructions on the mowing, rolling, edging and weeding of lawns.

A single event of this century that had a significant effect on the promotion of the development of the art of turfgrass culture was the establishment of the Royal and Ancient Golf Club of St. Andrews in Scotland in 1754. With this, the game that was to become universally known as "golf" received recognition as an established, on-going sport. The evolution of golf through the years, and the various requirements it has placed on turf for play, has served as a major impetus for the development of the framework of the basic concepts now used in various aspects of turfgrass culture.

The equipment used in turfgrass culture during this time was borrowed from the farm. Cutting of the grass, for example, was accomplished with hand scythes and cradles. The early part of the nineteenth century brought the invention of the first mowing machine for turf. The device was patented in 1830, and its manufacture began two years later.

The impact this machine had on the development of turfgrass culture as a systematic endeavor in which the various practices are centered on basic principles was equivalent to that of the establishment of the concept of allogenesis on the science of plant pathology. The capacity to maintain both specified and uniform heights of cut continuously with rather low investments in labor was the innovation needed in order for the unique features of the turfgrass plant to be fully utilized in a wide range of landscape and utilitarian situations. The motivation to exploit these now-recognized potentials led to the systematic programs of research and testing that have in turn established the various concepts and principles that comprise the art of turfgrass management.

As the nineteenth century progressed, the science of plant pathology developed both form and substance. A continuing series of discoveries firmly reinforced the allogenic concept of disease causality. In 1858, the first book based entirely on this concept was published.

Through the course of the century, the fungal incitants of several of the more important diseases of plants were identified. In addition to fungi, certain species of bacteria came to be recognized as being pathogenic to plants. At the close of the century, research was begun on determining the nature of what was being referred to as a "contagious living fluid". The pathogenic principle of this fluid would later become known as "virus", a previously unknown biotic entity.

It was during the final quarter of the nineteenth century that a major breakthrough in the area of chemical control of plant diseases was made. In 1882, Bordeaux mixture was discovered. With the advent of this very effective, low cost fungicide, the era of systematic research for the purpose of developing programs of plant disease control through the use of pesticides was ushered in.

While these various events were making their contributions to the nurturing of plant pathology into a mature science that would be fully capable of addressing itself to the task of determining the nature and control of disease, turfgrass culture was also becoming more clearly defined—both in the expectations from its efforts and its capacity to respond to these requirements. By the latter part of the nineteenth century, golf had become a very popular sport throughout the British Isles.

The year 1885 stands as a hallmark in the United States for both turfgrass culture and plant pathology. The first official golf club in the country was established in Yonkers, New York in 1885. This was also the year that turf research started in the United States. The location of this work was the Olcott turf gardens in Connecticut. It was also in 1885 that the United States Department of Agriculture's Division of Botany was established. This unit was to serve as the first administrative base for plant disease research in this country.

By the close of the nineteenth century, there were over 80 golf courses in the United States, and the first games of two other turf-dependent sports, football and baseball, had been played. The United States Golf Association had been formed. Research on turf management was being conducted on a much broader scale, and the nature and control of plant disease was being investigated at many of the state agricultural experiment stations.

As the twentieth century began to unfold, then all of the components needed for the establishment of the field of turfgrass pathology were in place. Many of the basic methods and techniques of turfgrass culture had been defined, and the science of plant pathology had matured to the extent that it could address itself constructively to identifying the causes of specific diseases and developing programs for their control. All that was needed to bring the parts together was a clear and present need. Ideally, this would be a disease capable of combining high incidence with high severity within a short span of time. While we now know of several diseases of turfgrasses that could have functioned well in this capacity, the lot fell to Rhizoctonia brown patch.

In 1914, a disease was observed to be causing extensive damage to a turf garden in Philadelphia, Pennsylvania. The owner of the garden, F. W. Taylor, was keenly interested in turfgrass culture and was active in both the development of management techniques and in the search for superior strains of grass. He was particularly interested in bentgrass culture, and his garden in Philadelphia contained several selections he had obtained from the Olcott turf gardens in Connecticut.

In his efforts to determine the cause of the disease at hand, Mr. Taylor secured the assistance of C.D. Piper, a member of the administrative staff of the United States Department of Agriculture and Director of the United States Golf Association Green Section. Isolations from the diseased plants yielded the fungus *Rhizoctonia solani* and it was determined that this organism was the incitant. Based on its characteristic clinical symptom pattern of foliage blighting and death of plants in irregular patches measuring up to 1 meter in diameter, Taylor assigned the disease the name "brown patch". The climatic conditions in 1915 were again particularly conducive to the development of the disease, and with the experience in diagnosis gained from the previous year, it was determined that brown patch was capable of causing severe damage to bentgrass putting greens.

With the pathogen identified, the symptoms known, and the scope of the disease defined, the next step was to search for a control. In 1917, field tests were begun by the United States Golf Association to determine the feasibility of using Bordeaux mixture for brown patch control. Although it was found that the material had certain limitations due to its toxicity to bentgrass after repeated applications, it was effective in controlling the disease, and there were no alternatives. By 1919, Bordeaux mixture was in general use on golf courses for control of brown patch.

Through this 5 year period, then, the "rest disease" had appeared. The extent of its occurence had been established, its incitant was identified, and control measures had been worked out. The components had been brought together and they had matched. The practice of turfgrass pathology had begun.

By the end of this decade, another turfgrass disease and its causal agent had been identified. This malady was first recognized on putting greens. Its symptom pattern was somewhat similar to Rhizoctonia brown patch, and it occurred at about the same time in the growing season. However, the individual blighted areas of turf were usually lighter in color and smaller in diameter. The two were distinguished from each other in name, then, by referring to the former malday as "large brown patch" and the latter disease as "small brown patch". Small brown patch (or "small patch") eventually became known as "dollar spot", and the pathogen was finally given the name *Sclerotinia homoeocarpa*.

During the 1920's, the clinical symptoms were described, the incitants identified, and the epidemiological patterns worked out for several newly recognized turfgrass diseases. In 1920, mercuric chloride was used successfully in the Chicago, Illinois area for control of Rhizoctonia brown patch on bentgrass putting greens. An organic mercury, Semesan (chlorophenol mercury) was tested in 1924 on the putting greens of a golf course near Yonkers, New York, and found to be very effective in the control of Sclerotinia dollar spot. By the end of the decade, the inorganic mercury chlorides and Semesan had become the primary fungicides used in the field control of turfgrass diseases.

In 1929, a turfgrass research and advisory service was established in Great Britain. The work was conducted under the auspices of the Board of Greenkeeping Research. The name of the organization was later changed to the British Sports Turf Research Institute. From the outset, the staff addressed itself to the solution of a broad range of problems in turfgrass culture, including determining the nature and control of certain diseases. The papers that have been published on the subject of turfgrass pathology in its journal are a valuable addition to the body of knowledge in this field.

The First Publication

The first comprehensive publication on the nature and control to turfgrass diseases was published in 1932. It was issued as an entry in the Bulletin of the United States Golf Association under the title TURF DISEASES AND THEIR CONTROL. The authors, John Monteith and Arnold S. Dahl, were two of the primary researchers in the field of turfgrass pathology in the late 1920's and early 1930's.

This publication stands as a classic, both for the thorough manner in which it integrates the principles and concepts of plant pathology with those of the practice of turfgrass culture, and the completeness of detail in its descriptions of the nature of many of the more important diseases of turfgrasses. Consideration was given to diseases incited by both biotic and abiotic entities. Control was approached from the standpoint of the use of resistant varieties and cultural methods, as well as through the use of fungicides.

The contribution of TURF DISEASES AND THEIR CONTROL to the development of the field of turfgrass pathology was far more reaching than bringing together in one volume a compilation of disease symptoms and control procedures. During this time, in plant pathology teaching and research the strongly pathogen-oriented school of thought of the nineteenth century was giving way to plant disease concepts centered more directly on the nature of the response of the suscept. The thinking of this more contemporary view of disease was very skillfully employed in the development of this publication. As the result, in addition to serving as a model for the design of the turfgrass disease research of its time, it also effectively set the stage for moving these investigations toward the holistically-oriented studies of the future.

As the 1930's began, turfgrass disease control programs were almost entirely dependent on either Semesan or the inorganic mercury chlorides. In 1931, however, it was discovered that thiram, an organic compound that had been developed as an accelerator in the manufacture of rubber, had fungicidal properties. Field tests showed that this material was effective in controlling several of the more important diseases of turfgrasses. Within a few years, thiram was in general use in turfgrass disease control programs.

The impact of thiram on turfgrass disease control programming was an interesting one in that it provided a basis for expanding rather than replacing the use of the organic and inorganic mercuries. It was found that when this compound was used as a tank mix with either mercuric chloride or Semesan, in addition to providing its own spectrum of fungicidal activity, it reduced to some extent the phytotoxic potential of the mercuries. As the result, the introduction of thiram established a new dimension in disease control — greater efficiency with less possibility of injury to the grass.

The transition to the present era in turfgrass pathology occurred during the 1950's and early 1960's. This was a time of major and highly innovative developments in both the field of turfgrass culture and the science of plant pathology. The Kentucky bluegrass cultivar 'Merion' was released in 1952. This was the first of what was to be a continuing series of releases of new genotypes of *Poa pratensis*. Within the following two decades, it would be joined with similar series of releases of bentgrasses, fine bladed perennial ryegrasses, tall fescues, Bermudagrasses, and zoysia. Each cultivar brought with it certain peculiarities of management requirements, and each had its own pattern of response to the various pathogenic entities.

New formulations of nitrogen-based fertilizer for use in turfgrass culture began to be tested and placed into field

Shallow rooted turf, poor moisture distribution, from area not treated with Aqua-Gro amended water.

Deep rooted turf, good moisture distribution from area treated with Aqua-Gro amended water.

use. Each had its own rate of nitrogen release, and each had its own set of requirements for release.

New types of turf maintenance equipment began to make their way into field use. Each made its own contribution to the enhancement of grass growth and each placed its own forms of stress on the plants.

Each of these innovations added to the latitude of selectivity within the field of turfgrass culture for producing particular types of turf. However, they also presented to the turfgrass pathologist extremely complex patterns of mobility where the expression of disease was concerned.

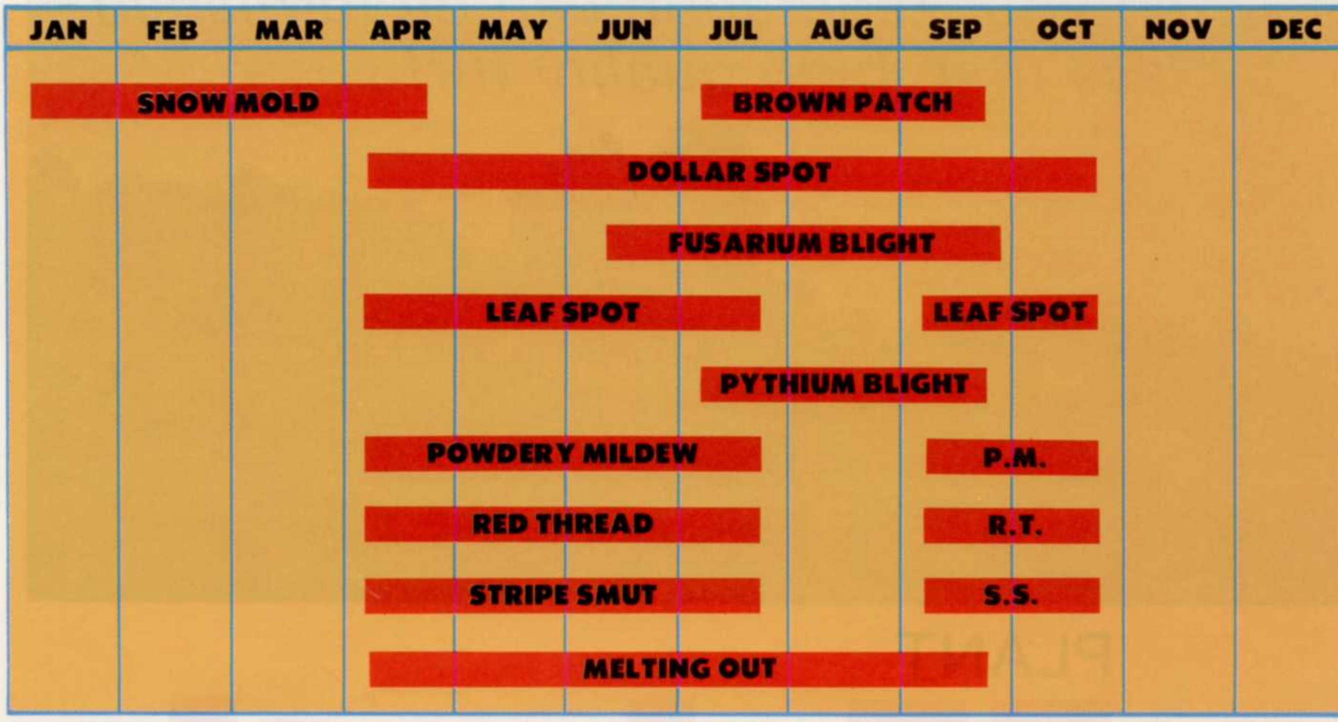
The basis for the pathologist's capacity to respond to the newly developing pattern of turfgrass culture also came into being during this decade. The English translation of Principles of Plant Infection by Ernst Gaumann was printed in 1950. This action gave a much broader exposure within the scientific community to what was unquestionably the most significant publication in plant pathology in the first half of the twentieth century.

The principles put forth by Gaumann in his book established the mentality by which the dynamics of disease development could be viewed with equal clarity at both the reductionist and constructionist levels. They permitted the development of a basic concept of disease that was truly functional in all circumstances. It was a concept that transcended such previously limiting factors as the nature of the incitant and/or the magnitude of the plant's response. The groundwork laid by the nineteenth century concepts, and built upon by the emphasis placed in the research of the first half of this century on determining the nature of the response of the suscept, now found full expression in the concept of disease proneness.

Disease proneness views each plant as being genetically endued with its own innate capacity to become diseased. Expression of the various facets of this proneness is made manifest when the appropriate combinations of the physical environments are brought into being. Through this concept, disease is seen in its absolute reductionist sense as simply the moment of the initiation of aberrent metabolism, and in its absolute constructionist sense it is seen as the moment of expression of the most salient features of its clinical symptoms.

Both of these moments of disease, and the acceptance of the legitimacy of their being, establishes the means by which all of the factors relating to the ultimate outcome of the pathogen-suscept interactions can by given proper perspective. Disease proneness, then, becomes the route to a truly holistic view of disease. Within the concept of disease proneness, for example, the causality of disease is seen as a matrix of events rather than a single episode. This means that the determination of the etiology of a disease is more than a search for a single entity. Rather, the objective of research on disease etiology is to determine the order of occurence of these events and how they interrelate in both the initiation of the process of disease and in the fostering of the development of its clinical phase.

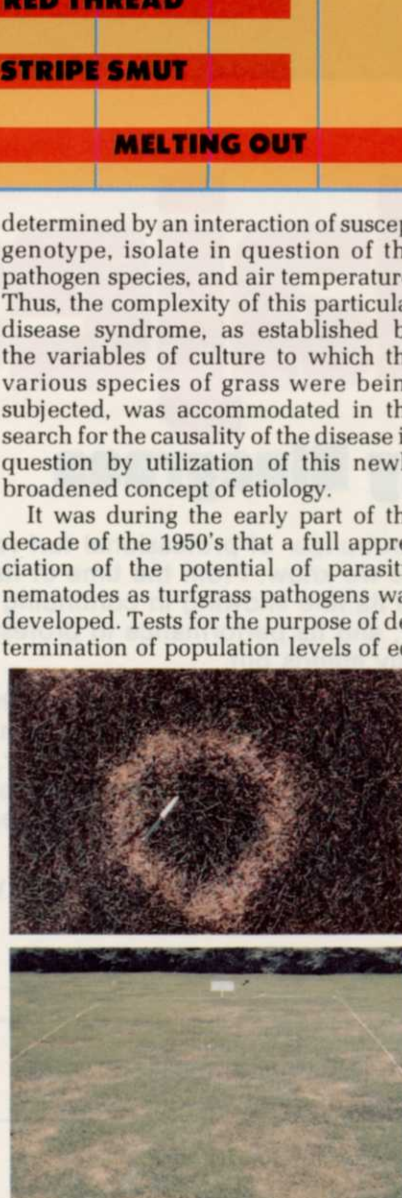
The opportunity to apply these concepts to research on a turfgrass disease of unknown etiology came during the first years of the following decade. In 1959, a previously undescribed disease of Kentucky bluegrass characterized in



its final stages of development by more or less circular patches of blighted grass 0.6-1 meter in diameter was observed in southeastern Pennsylvania. During 1960, 1961 and 1963, the disease became epiphytotic in stands of Kentucky bluegrass and creeping bentgrass in the south central and eastern parts of the state. Also, during this time, the malady was observed on a wide range of cultivars of bluegrass, as well as creeping bentgrass and creeping red fescue in Ohio, New York, New Jersey, Delaware, Maryland and the District of Columbia.

The experiments for the purpose of determining the etiology of the disease were designed to take the candidates through series of multiple factoral tests for levels of pathogenicity. The factors in the respective experiments included variations in (i) air temperatures, (ii) nutritional levels of the test plants, (iii) test plant geneotype, (iv) isolates of the same species of pathogen candidate, and (v) levels of propagule density of the same isolate of pathogen candidate. Isolates taken over a 5 year period were subjected to these series of tests. It was found that the biotic components of the etiology of this disease were *Fusarium roseum* f. sp. *cerealis* 'Culmorum' and *Fusarium tricinctum* f. sp. *poae*, and that these entities were able to function in a primary capacity — both in infection and in colonization of the suscept tissue. In addition, it was found that the degree of resistance to colonization is influenced by the nutrition of the suscept. Also, the level of resistance within *Poa pratensis* was found to be determined by an interaction of suscept genotype, isolate in question of the pathogen species, and air temperature. Thus, the complexity of this particular disease syndrome, as established by the variables of culture to which the various species of grass were being subjected, was accommodated in the search for the causality of the disease in question by utilization of this newly broadened concept of etiology.

It was during the early part of the decade of the 1950's that a full appreciation of the potential of parasitic nematodes as turfgrass pathogens was developed. Tests for the purpose of determination of population levels of ectoparasitic forms in the root zones of turfgrasses soon became commonplace. Midway through this decade, post planting nematicides were being included as regular entries in the lists of plant protectants used in many turf management programs.



Fusarium blight *is most often characterized by a circular area of reddish-brown grass with green grass in the center.*

The close of the 1950's and the beginning of the 1960's was also the time period in which the first books on the nature and control of turfgrass diseases were published. In 1959, the British Sports Turf Research Institute issued FUNGAL DISEASES OF TURFGRASSES by J. D. Smith. Three years later, DISEASES OF TURFGRASSES by H. B. Couch was printed. Smith's book covered the more important diseases of turfgrasses in Great Britain. It went into its second edition in 1965. The book by Couch was a treatment of all known turfgrass diseases, and its second edition was released in 1973.

Throughout the 1950's, and on into the following decade, there was a sharp increase in the frequency of introduction of new fungicides for use in the field control of turfgrass diseases. By 1964, this rapid influx of new pesticides had slowed considerably.

It was in 1963 that the existence of resistance to anilizine by *Sclerotinia homoeocarpa* was reported. This was the first verified instance on the part of a turfgrass pathogen of the development of resistance in the field to a pesticide. Within a few years, episodes of both anilizine resistant and cadmium resistant *Sclerotinia homoeocarpa* had been reported from several locations in central and northeastern

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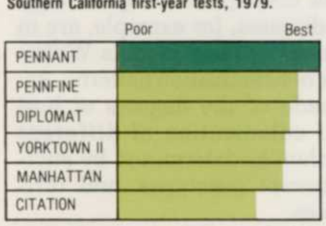
Warm and cool season average turf score, Southern California first-year tests, 1979.



Percent winter injury. Adelphia, N.J. March 1978. (10 of 26 varieties tested showed no significant injury.)

PENNANT	0%
MANHATTAN	0%
CITATION	11%
DERBY	14%
PENNFINE	18%
LINN	38%

Pennant was best among 12 varieties tested for red thread disease (Corticium fuciforme) in 1-year average, 1979-80. Western WA. (Low score = Best).

PENNANT	20.7 %
CITATION	23.6 %
DERBY	26.3 %
PENNFINE	30.4 %
MANHATTAN	40.4 %
YORKTOWN II	47.8 %

Average Turf Performance scores, February 1980. Southern Arizona turf overseeding on Tifgreen Bermuda. Sixteen entries seeded October 1979. (10 = Best).

PENNANT	7.7
PREMIER	7.3
REGAL	6.3
CBS	5.7
DERBY	5.5
ANNUAL	2.3

*Plant variety protection pending and anticipated

Turf performance scores. North Brunswick, N.J. 1975-78. (9 = Best).

YORKTOWN II	6.4
PENNANT	6.3
CITATION	5.9
DERBY	5.4
PENNFINE	5.4
MANHATTAN	5.2

Reaction to brown patch disease (Rhizoctonia), Adelphia, N.J., 1978. (9 = least damage)

PENNANT	7.5
YORKTOWN II	7.0
CITATION	7.0
REGAL	6.3
DERBY	6.2
PENNFINE	5.8

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United States and southeastern Canada.

By the end of this decade, the expressions of public concern over the possible harmful side effects of pesticides on the quality of the environment began to be felt in turfgrass disease control programs. In 1970, the manufacturer of Semesan voluntarily removed the product from the market. The use life of this material as a mainstay in turfgrass disease control programs had spanned almost five decades. It had served well in the control of a broad spectrum of important diseases, and its departure was lamented by many.

The first commercially available systemic fungicides for use on turfgrass were marketed in 1970-71. These were benomyl and thiabendazole. Later investigation of the interactions of various aspects of the physical environment and certain practices in turfgrass culture on the effects of these materials on both the incidence and severity of target and non-target diseases, as well as the growth patterns of the suscepts, pointed to the need for the establishment of more precisely defined parameters for the field testing of systemic fungicides. Also, within a few years, instances were being reported of resistance in the field of *Erysiphe graminis* and *Sclerotinia homoeocarpa* to members of this benzimidazole grouping. These observations served as an additional impetus to the development of specific guidelines for field use of systemic fungicides in turfgrass culture.

The Future

In the future, the design of major research efforts in turfgrass pathology will become more closely oriented with the concepts of holopathology. Turfgrass culture is unusually well suited for the development of research models based on the holistic view of disease. The wide range of suscept genotypes that have been developed within the various turfgrass species provides a broad array of potential responses to various environmental stresses. The equally wide range of growing conditions to which the plants are systematically subjected establishes the vehicle through which these innate abilities can be brought into full expression. Holopathology is the vehicle by which this matrix of events can be described, and their relative degrees of interdependence and individual roles in the initiation and fostering of the disease process can be defined.

In addition to continued work with Fusarium blight, there are several other known turfgrass diseases that need to be subjected immediately to research that has been designed within the concept of holopathology. The Rhizoctonia-incited diseases, for example, are in much need of research based on these models. Within this grouping is a complex of colonization patterns. Assessment is yet to be made of the degrees of host specificity and types of colonization of different isolates of *Rhizoctonia solani* as determined by environmental conditions, suscept genotypes, and turfgrass management practices.

This same research approach needs to be applied to the Pythium-incited diseases, Sclerotinia dollar spot, Fusarium patch, and Typhula blight. Of the diseases in which the principle components of their causalities have yet to be determined, spring dead spot of Bermudagrass is an example of one that should be studied through multiple factoral experiments designed within the parameters of the holistic concept of disease.

In the near future, the basic principles that have been established in the field of epidemiology will begin to be utilized more widely in research on forecasting the outbreaks of turfgrass diseases. The evident benefits of being able to time applications of fungicides on a disease preventive schedule that has been determined by a system of objective analyses of the physical and biological environments will foster increased research in this area.

The view of the spectrum of entities with pathogenic potential to turfgrasses will continue to expand in the years ahead. Additional viruses and mycoplasm-like organisms that are pathogenic to turfgrass will be included in this list. Also, the role and nature of bacteria as incitants of turfgrass diseases will be clearly defined. Within the realm of abiotic entities, the presently increasing appreciation of the importance of air pollutants as incitants of turfgrass diseases will lead to research on the nature and control of these disorders.

In the area of turfgrass disease control, the development of cultivars will include screening techniques that are based on the presently increasing knowledge of the need to identify the degree of stability of the suscept genotype to nutrition-induced changes in disease susceptibility. Research on the chemical control of turfgrass diseases will become more sophisticated. Techniques of pesticide application will be receiving more attention than has been given to this area in the past. Also tests for the field screening of systemic fungicides and nematicides will include such parameters as (i) possible increase in incidence of non target diseases, (ii) the possibility of latent phytotoxicity, (iii) the relationship of leaf surface temperature, nutrition, and soil moisture stress to phototoxicity, and (iv) the longevity of control.

In the distant future, there will no doubt come another time of transition to a new era in the field of turfgrass pathology. As has been the case in the past, however, its timing will be determined by the nature of the changes in the techniques and procedures of turfgrass culture and the development of principles and concepts in the science of plant pathology that are applicable to the solution of the new expressions of disease that they will have fostered.

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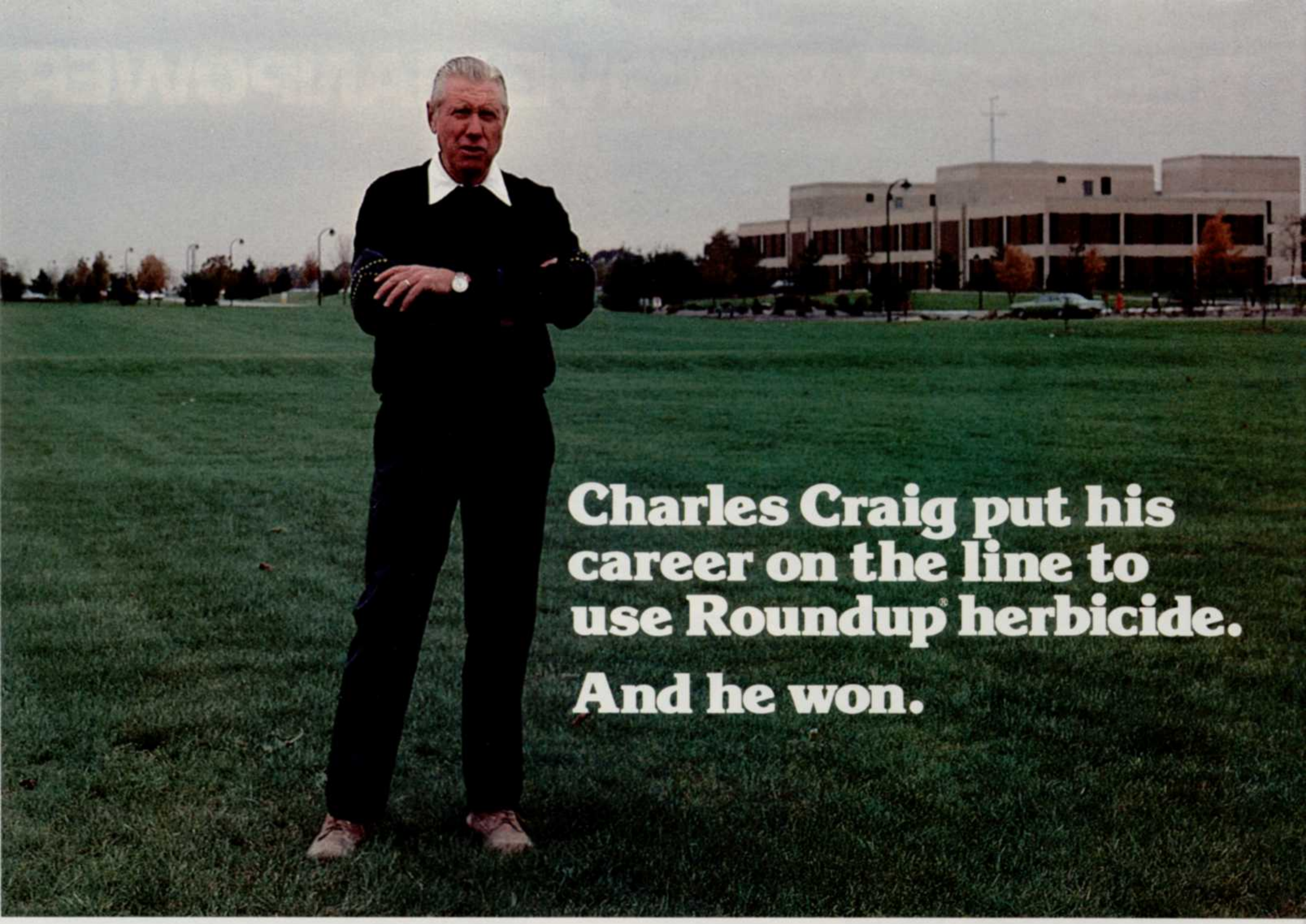

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STRONG HABIT OF SPRUCE DOMINATES HOMES YET FITS INTIMATE AREAS

By Douglas Chapman, Horticulturist, Dow Gardens, Midland, MI

Spruce *(Picea)* makes an effective tree for golf courses, institutional grounds, parks, and large-area landscapes. It is also a fine specimen and attractive in mass plantings. Spruce grow native in the cool-humid-boreal region of the country from New England through the Great Lakes to the West Coast. Species spruce are fairly stiff and formal. Their habit is a strong vertical line which can dominate home landscapes, yet cultivars have been developed which fit small, intimate landscapes. When young, the trees are thick; while at maturity, the lower branches thin or die off destroying the landscape effectiveness. They are sun dependent. Shade or competition from other trees will cause thinning, decline, or death. Generally, *Picea* grow best in fertile, moist, yet well-drained soil.

Cytospora canker, heartwood decay (fomes), root rot, rust, and needle cast will attack spruce. Cytospora canker is the most devastating. It limits the useful life of Colorado Spruce *(Picea pungens)* to 20 to 25 years in much of the Midwest.

Insect problems include galls, aphids, budworm, spruce needle miner, scale, and mites. Aphids, spruce needle miner, and mites are the most difficult insects to control in the Midwest. Bagworm causes a significant problem in the Southern Great Lakes, e.g., Illinois, Indiana, and southern Ohio.

The most important species of spruce in the Midwest and Northeast are Norway, White, Serbian, Oriental, Englemann, and Colorado.

Norway Spruce *(P. abies)*, a native to Europe, is an outstanding spruce for the Midwest and Northeast. It prefers cool, humid climates, and is very hardy to -72°F., depending upon provenance or local adaption. *P. abies* has a shallow root system and will grow in sandy soil with a relatively high water table. When young, it is a stiff, formal plant; at maturity, this 60-foot tree becomes graceful with pendulous branches. The 4- to 6-inch long cones are cylindrical and hold on for the entire winter. The contrast against a dark green foliage is spectacular. Norway Spruce tolerates salt spray but not soil-applied chlorides. It is an effective specimen tree for large area mass plantings or at the borders of open areas. I feel it is the most graceful and effective of the species spruce.

Several cultivars of Norway Spruce work well for home landscapes. They include 'Maxwell,' 'Nest,' and 'Remont.' 'Maxwell' Norway Spruce *(P. abies*

Steel blue needles (above) accentuate the Colorado Spruce, which grows in a wide range of soils but is very susceptible to Cytospora canker.

Servian Spruce (*P. Omorika*—left) grows in a dense, symmetrical fashion and reaches an effective landscape height between 40 and 50 feet.

Spruce *from page 41*

'Maxwellii'), a dwarf, low globe, growing about one inch a year, has short, bright green needles completely surrounding the stems. 'Nest' Norway Spruce *(P. abies* 'Nudiformis') is a dwarfed, somewhat flat-top globe, growing 2 to 4 inches in height each year with an ultimate height of 7 to 10 feet. 'Remont' Norway Spruce *(P. abies* 'Remonti') is a wide, conical dwarf, reaching 12 feet in height. It grows 4 to 6 inches annually and has brilliant green foliage. These cultivars are extremely effective as accent plants in intimate areas.

White Spruce *(P. glauca)* is a broad, pyramidally-shaped tree when young, and becomes somewhat ascending at maturity. Its ultimate peak height ranges between 40 to 60 feet with a spread of 10 to 20 feet. White Spruce is particularly effective in mass plantings, tolerating shade more than Norway or Colorado Spruce. The leaves are ½-inch long, usually crowding the upper side of the stem. They are pale green to glaucous in color. White Spruce transplants readily in moist, loamy soils. Some of its outstanding characteristics include good tolerance to wind, heat, cold, drought, and especially crowding, which is exceptional for spruce. It is most effective in mass planting or groups (3-5) and has a fairly rapid rate of growth.

Engelmann Spruce *(P. engel mannii)* is native throughout the Cascades from British Columbia to New Mexico. It is perfectly hardy, withstanding temperatures from -50°F. to a high of 90°F. In its native range it often reaches 100 to 120 feet in height; in the Midwest, this dense, narrow, pyramidal tree rarely reaches over 50 feet in height. It has been reported tolerant to sulfur dioxide and chloride sprays. Disease problems are rare, showing a high degree of resistance to Cytospora canker and heartwood rot (fomes). This species has a coarse texture due to 1-inch long blue-green needles. Engelmann Spruce should be considered one of the outstanding spruce, ranking as high as Norway or White Spruce. In fact, Wyman considered it the best of the ornamental spruces available. As a species or accent in large areas, this plant should be emphasized to increase availability in the trade.

Servian Spruce *(P. Omorika)* is an extremely effective dense, symmetrical tree. It grows slower than Norway Spruce, reaching an effective landscape height between 40 and 50 feet, but has been reported over 100 feet in height. It is native in southeastern Europe. The foliage is a good dark green. *P. omorika* is particularly effective for industrial and park landscapes. It does require some winter protection or placement in a north or northeast side of buildings in fertile soil that is well-drained.

Oriental Spruce *(P. orientalis)* is a dense, compact pyramidal tree with horizontal branching. Its effective

Continues on page 55

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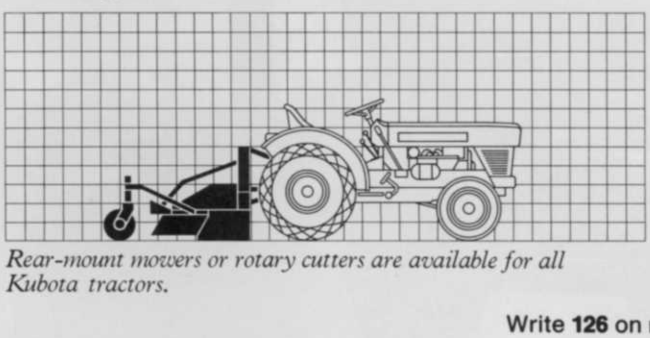

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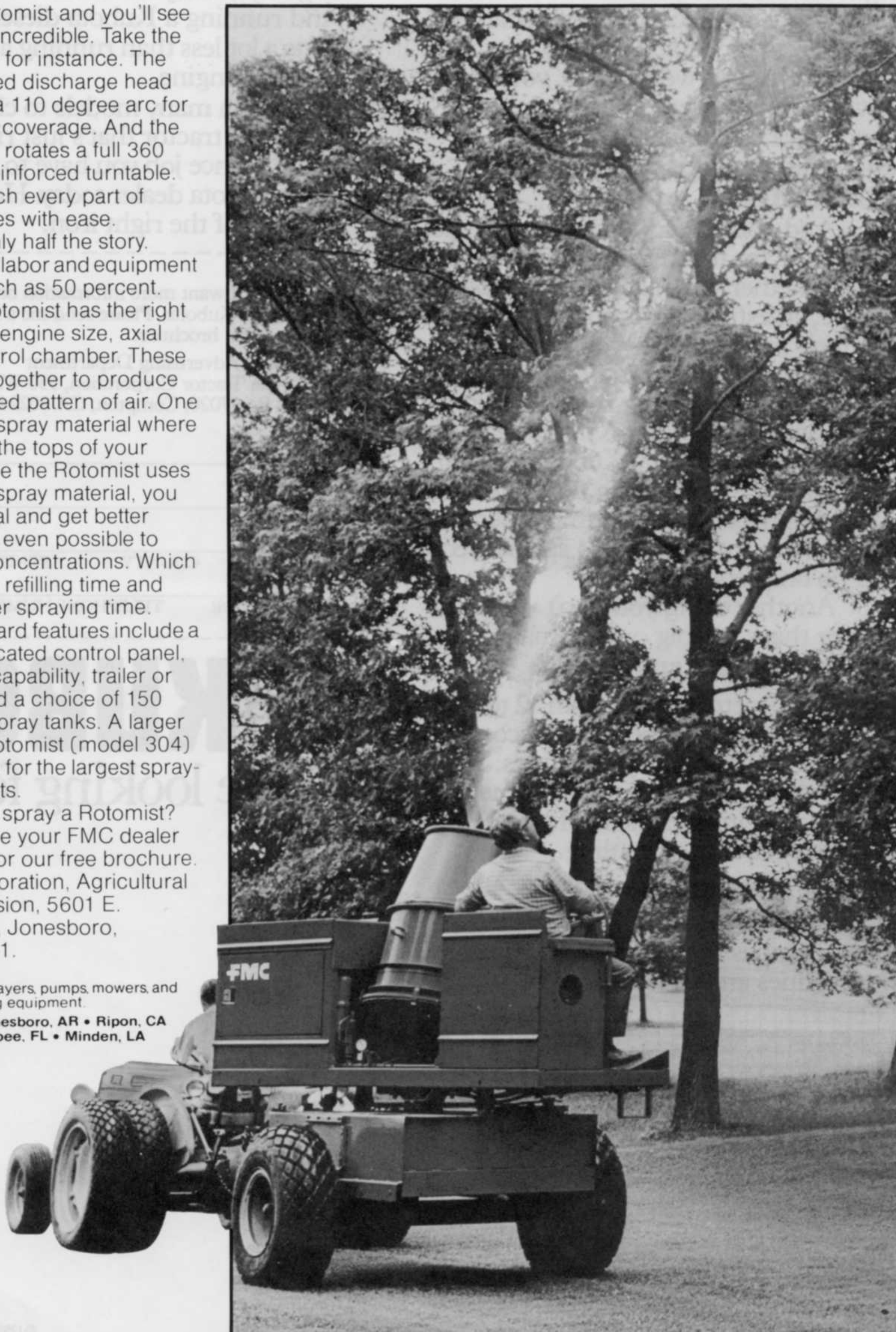

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REVEGETATING MASSACHUSETTS HIGHWAYS WITH AN ARRAY OF WILDFLOWER SODS

By Douglas L. Airhart, assistant professor, Dept. of Plant Pathology and Soil Sciences, University of Massachusetts, Amherst, MA

The task of revegetating and maintaining roadsides is a major concern of highway engineers. Shallow, acid soils with low fertility and poor moisture retention, steep slopes, and southern exposures make challenging problems.

Improved safety specifications have forced areas to be regraded, which requires revegetation. The best solution for these areas would be to establish native plants that are aesthetic yet permanent, requiring minimal cost and maintenance. The standard practice has been to seed with grass, but grasslands are not a natural or climax vegetation in New England and proper maintenance is quite costly.

Another approach, to seed and plant native wildflower species along roadsides, has been established in many prairie states as an alternative to grasses. The flowers chosen are native, sometimes endangered in the area, and are not necessarily limited to highway use (5). Some problems still exist with wildflowers since some seeds are prohibitively expensive, dormancy requirements and grass or plant competition are not fully understood, and methods of establishment have not been specified. The use of sods for plant establishment has been practiced with turf (3) for a number of years. More recently, improved sods have been prepared using plastic netting to reinforce turf (4) or landscape materials (7). These sods provide quick and effective ground cover with proper handling, and can be used for slope stabilization or erosion control (6). Increased interest in roadside beautification has supported the use of wildflower species for plant cover and slope stabilization along highways.

Although some methods have been compared (2) for Massachusetts highways, the most successful method has not been selected. This project was designed to test the adaptiveness of wildflowers being studied on Massachusetts highways for sod production and the ability of these wildflower sods to become established on highway slopes.

Materials and Methods

The seeding rate study was conducted in French Hall greenhouses on the University of Massachusetts, Amherst campus (U.Mass.). In this test, four seed rates of each of thirteen wildflower species were compared in completely randomized design. The control seed rates varied with suppliers recommendations, and multiple rates of 5, 10, and 20 times were the treatments (Table 1). Sod seedbeds were prepared, using plastic trays (28 x 26 x 5 cm) known as half flats, with a pine barkpeat substrate above and below a piece of Spartan cloth netting to serve as a root binder.

The varieties tested were Black-eyed Susan *(Rudbeckia hirta)*, Blanketflower *(Gaillardia aristata)*, Butterfly Milkweed *(Asclepias tuberosa)*, Chicory *(Chicorum intybua)*, Daisy *(Chrysanthemum leucanthemum* 'Alaska' and 'Ox-eye'), Dame's Rocket *(Hesperis matronalis)*, Evening Primrose *(Oenothera lamarkiana*, Purple Coneflower *(Echinacea purpurea)*, Prairie Coneflower *(Ratibida columnaris)*, Spiked Gayfeather *(Liatris spicata)*, and Yarrow *(Achillea millefolium)*. Seeds were sown by hand on the

Table 1. Species, Name, Source and Recommended Seed Rates of Wildflowers used in Sodding[z] Study.

Wildflower species	Common Name	Source[y]	Recommended Rate g/HF	Recommended Rate lbs/Ac
Achillea millefolium	Yarrow	H	.0104	1
A. millefolium	'Roseum' Yarrow	E	.0104	1
Asclepias tuberosa	Butterfly Milkweed	H	.0520	5
C. leucanthemum	'Alaska' Daisy	H	.0624	6
C. leucanthemum	'Ox-eye' Daisy	E	.0624	6
Cichorium intybus	Chicory	E	.0520	5
Echinacea purpurea	Purple Coneflower	E	.1249	12
Gaillardia aristata	Blanketflower	E	.1041	10
Hesperis matronalis	Dame's Rocket	H	.0832	8
Hesperis matronalis	Dame's Rocket	E	.0832	8
Liatris spicata	Spiked Gayfeather	E	.1249	12
Oenothera lamarckiana	Evening Primrose	E	.0312	3
Ratibida columnaris	Prairie Coneflower	E	.0312	3
Rudbeckia hirta	Black-eyed Susan	H	.0416	4
Rudbeckia hirta	Black-eyed Susan	E	.0416	4

[z]Seeds sown on peat-pine bark medium in 28 x 26 x 5 cm plastic half-flats (HF) under greenhouse conditions (15° C. NT).

[y]E = Environmental Seed Producers, El Monte, CA 91734; H = Herbst Bros. Seed, Brewster, NY 10509.

surface of the substrate and germinated in the greenhouse at 15°C. night temperatures with intermittent misting. After germination, seeds were fertilized weekly with 200 parts per million nitrogen from soluble 20-20-20 fertilizer. Evaluations for sod use were based on the uniformity of plant cover and density of root growth after eight weeks while transplanting into field plots. After 1 year, sods were again examined for overwinter survival and spread into adjacent areas.

The same species were prepared (June, 1979) at the best seed rate for testing on highway slope areas. The test was located on a 2:1 sandy slope facing southwest along I-91 northbound in Bernardston about two miles south of the Vermont border. Plant establishment was evaluated in September and December, 1979.

Results and Discussion

The best seed rate for satisfactory sod formation of each species was as follows:

The field seed rate was satisfactory for sod formation of Black-eyed Susan, Evening Primrose and Yarrow, but other species required 5 or 10 times the field seed rate to produce sods. Spiked Gayfeather required 20 times the field rate, which may be economically unfeasible. These seed rates may appear high, but one report (1) stated that four times the recommended rate produced longer and more effective blooming of two wildflowers. A pinestraw mulch increased plant establishment in most cases. If these sods can by placed on bare or critical slopes, natural spreading may be encouraged without expensive treatments or equipment being needed. The grouping or patchy appearance would not be unlike other grass or flower patches that appear on Massachusetts highways, particularly on steep slope areas that are minimally maintained even though they are extremely visible to motorists.

All but four species survived well in the field trial, with half of the survivors beginning to spread into adjacent areas. Winter snow cover was mild, which may have caused part of the mortality due to poor insulation or moisture loss from the substrate. Some plants appeared dead when examined in early spring, but had revived by early summer. Those that spread—Yarrow, Black-eyed Susan, Ox-eye Daisy, Evening Primrose—are recommended for further study for critical slope stabilization.

The response of the highway trial was slightly different, with all but 5 species surviving. Dame's Rocket and Purple Coneflower were not successful survivors in this trial. The slope is steep and sandy, with little cover besides mosses, and the weather was hot and dry when the sods were set out. Water was applied weekly for three weeks after planting but conditions were extreme. The number rooted and alive decreased more than expected, but the winter

Continues on page 50

appearances may not be a true indication of survival or death. There was no indication of spreading into adjacent areas at the last examination (December, 1979).

Wildflower sods can be easily prepared using the techniques described here, although a root binder and high seed densities are required. The binder material can be plastic or cloth netting, with little differences in sod stability between them if roots are given sufficient time to develop. Eight weeks was sufficient time for fine netted cloth, but loose netted plastic may require a longer development period. The binder material serves an additional use when planting on slopes, since excess binder can be covered with soil to help retain the sod and soil adjacent to the sod.

The tap-rooted varieties, Butterfly Milkweed and Spiked Gayfeather, were most difficult to establish and handle as sods, and were not completely satisfactory. Sods of Black-eyed Susan, Ox-eye Daisy, Evening Primrose and Yarrow were first to become established and spread into adjacent areas, by seed or root growth. If suitable, these would be the first varieties to attempt for sodding roadside slopes, although other varieties may be more suitable in different areas.

Time of planting and weather (moisture) conditions may be more critical than sodding method or plant species. The sods can be treated as a container crop, fertilized, hardened off before planting, or held for periods of time until planting conditions are favorable. Flowering may occur before transplanting with Black-eyed Susan, but no apparent setback was noticed in these trials. The sods were easily handled and could be cut into smaller sections to fit small spaces or spread more effectively on slopes. Wildflowers may be established quickly and easily with this sodding method, which may provide the nucleus for establishing larger colonies on inaccessible areas or other areas needing low maintenance and colorful display.

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VEGETATION MANAGEMENT

By Roger Funk, Ph.D., Davey Tree Expert Co., Kent, Ohio

Q. *Last winter many of my young trees were damaged by mice. Several years ago we used a chemical to paint the trunks but I can't remember its name.*

A: The product probably contained Thiram, which is a taste repellent registered for use against mice. One application applied before damage starts should protect the plants during the dormant period.

Q: *How can I easily tell if the trees I bought from a local nursery are really Chinese elm and not Siberian elm? I do not have any horticultural training.*

A: The easiest way to identify the two species is the time of flowering. Siberian elm *(Ulmus pumila)* blooms in spring before the tree leafs out, whereas, Chinese elm *(Ulmus parvifolia)* blooms inconspicuously in the fall. Also, the buds in the axils of the leaves of Siberian elm are noticeably larger than those of Chinese elm and have a purplish coloration.

Q: *How can I prevent sapsucker feeding on hemlock trees?*

A: Sapsuckers are protected under the Migratory Bird Treaty Act so I wouldn't attempt anything too drastic. If practical in your situation, you might protect the feeding area with hardware cloth or burlap wrap.

Q: *What can be done to protect a tree from an oil spill over a fairly large portion of the root system?*

A: If the tree is small, it could be replanted in a new location after washing contaminated soil from the roots. There is no practical way to treat large, established trees. Stimulating more rapid biodegration of the spilled oil by drill-hole aeration (which also helps replace oxygen utilized by the microorganisms), fertilization and liming to correct an acid soil reaction may be helpful.

Q: *What can be done to improve the condition and appearance of trees injured by broadleaf herbicides applied to a lawn?*

A: There is no specific treatment to alleviate the injury. In most cases trees recover and will appear normal in two or three years. Pruning the affected branches may help the appearance of the tree. Additional water may also be helpful, but it would probably be best not to fertilize the trees until they show signs of recovery.

Q: *Our maintenance crew mistakenly applied a herbicide containing Bromacil around the base of some trees. What can be done to protect the trees from injury?*

A: Since Bromacil is water soluble, water should NOT be applied. Water would help distribute the herbicide throughout the root zone, increasing the potential for injury.

Activated charcoal can be distributed over the treated area to neutralize the chemical. Soil incorporation gives better results since much of the Bromacil may have already penetrated into the soil.

Q: *What will control moss in a lawn?*

A: Chemicals such as copper sulfate, ammonium sulfate, and mercurous chloride will temporarily control moss but it will return unless the conditions for turfgrass growth are improved. Factors which favor moss are heavy shade, poor drainage, low fertility, scalping, and improper soil pH.

Q: *Several of the lawns that we service are full of mounds of soil which I was told were caused by crayfish. How do we get rid of them?*

A: Crayfish are a problem on poorly drained soils with a high water table. If it is not practical to improve the drainage, contact your local cooperative extension agent about the status of chlordane. A dilute solution poured into the holes has reportedly been helpful in ridding an area of crayfish.

Q: *We have all heard or read the advantages of top-dressing. What about discussing the problems?*

A: Top-dressing applies a thin layer of soil on established turfgrass to help control thatch, smooth the soil surface, and facilitate more rapid recovery from stresses. Top-dressing can also change the characteristics of the rooting environment which may have a detrimental effect on rooting.

The most serious problem associated with top-dressing is the formation of soil layers. When a soil is used for top-dressing which is a different type than the underlying soil, a layer of interface is formed. Interfaces resist penetration of water and inhibit gaseous exchange between the soil and atmosphere, thus restricting root growth.

The use of sand as a top-dressing on a clay soil requires special attention to minimize the effect of layering. Current evidence suggests that once sand top-dressing is initiated, continued use of sand is necessary to prevent future problems. In addition, if coring is practiced to allow sand incorporation in the coring holes, the cores from the holes should be removed.

If the existing soil has favorable characteristics, the use of a similar soil for top-dressing will eliminate the problem of layering.

Send your questions or comments to: Vegetation Management c/o WEEDS TREES & TURF, 757 Third Avenue, New York, NY 10017. Leave at least two months for Roger Funk's response in this column.

SOD PRODUCER NEWS

Study determines effects of fungicides on thatch and pH

Different fungicides induce significant variations in thatch accumulation, according to research of Dr. Smiley, assistant professor of turfgrass pathology at Cornell University.

After testing 14 fungicides and one nematicide on Kentucky bluegrass turf through three seasons of application, Smiley found that some spur significant accumulation of thatch while others cause little or no accumulation.

"Our results indicate that decomposition of thatch was possibly impeded through the inhibition of microbial activities by unfavorable pH environment and/or by direct toxicity of the fungicides," said Smiley.

He said that decomposition of sulfur-bearing fungicides contributed sufficient acidity to inhibit the decomposition of thatch and these acidification processes explain the magnitude of thatch accumulation in most instances.

The study prompted Smiley to say that too often fungicide choice is made only by taking immediate cost and target pathogens into consideration, without considering the long-term effects which the fungicide may have.

Sod roof makes good insulator, attracts international attention

An Encino, CA, couple caught the attention of many people passing by and news media from different countries when they installed 3,000 feet of bluegrass sod on their roof.

JoAnn and Kenneth Cowans spent seven years researching the project, especially the subject of transpiration cooling. Their whole purpose behind installing the sod roof was the tremendous cooling and cost benefit it provides. Their electric bill has been cut by half to two-thirds since the sod was put in, and the temperature in the house during the winter months is milder.

Mowing takes about two hours and is a challenge. Peaks and a network of irrigation lines on the roof can be easily damaged. The bluegrass itself is susceptible to heat damage and fungus, and the Cowans require professional help.

Help comes from the company who grew the sod, Pacific Green Sod, Camarillo, CA. President Richard Rogers said, "This was probably the most publicized 3,000 feet of bluegrass we ever grew." The story appeared on the front page of the Los Angeles Times, was the subject of two television interview, and drew media calls from Canada and Europe.

Pennsylvania Turfgrass Council builds display for museum items

Funds from the Pennsylvania Turfgrass Council and collected turfgrass memorabilia are helping to build a new area of museum pieces on the Penn State University campus.

The council, which has grown to about 400 members, is funding the cost from membership dues, trade shows, and turf schools. All types of turf equipment, donated by golf course superintendents and other grounds managers, have accumulated to warrant their own housing.

Dr. Joseph Duich, professor of turfgrass science and liaison between the council and university, said some of the items date back to the early days of turf equipment. These include early sod cutting equipment, sickle mowers with two blades, old spiking and brushing equipment, early aerifiers, punches, fertilizers, spreaders, and seeders. Turfgrass students are sandblasting the metal and refinishing the equipment.

Dutch expects that the building will be constructed by the end of the year.

Duich

Spruce *from page 42*

landscape height at maturity is between 45 and 55 feet, although native plants have been found reaching heights of 110 to 120 feet. Its rate of growth is somewhat slower than White Spruce. Soils with much gravel don't bother *P. orientalis*. When used in the Midwest, some form of winter protection is desirable. Some plantsmen have reported Oriental Spruce is more graceful than Norway or White Spruce, but in our experience, Norway Spruce is hard to beat.

Colorado Spruce *(P. pungens)* is one of the most widely-used spruces throughout the Midwest. In fact, it is almost overused. It is broadly pyramidal with a stiff horizontal branching, often reaching 40 to 50 feet in height with a 15- to 25-foot spread at maturity. *P. pungens* is native to the Southwestern United States and the Rocky Mountain area. Colorado Spruce grows in a wide range of soils, thriving in well-drained fertile soils but tolerating heavier clay soils of the Midwest. The needle is ¾ to 1½ inches long and glaucous-green. The desired plant has a steel blue foliage color. *P. pungens* is very susceptible to Cytospora canker, often succumbing in the first 15 to 20 years. In fact, there are few *P. pungens* in Central Michigan which are not affected at 30 years of age by Cytospora canker, which, of course, leads to general decline or death.

One of the most outstanding cultivars of Colorado Spruce is 'Honnewell' (*P. pungens* 'Hunnewelliana'). It is dwarf, somewhat conical, and silver to deep blue in color. It grows at a greatly reduced rate while integrating well into most intimate or home landscapes. 'Koster' Blue Spruce *(P. pungens* 'Kosteriana') is a sharp, deep blue cultivar, and quite formal. Its habit of growth is normal for Colorado Spruce, but can be narrow. A deep blue color distinguishes its attractiveness.

Most spruce are truly sentinels in the landscape. They grow best alone or in small groupings. The few companion trees to spruce would be large pines, e.g., White Bark Pine *(Pinus albicaulis)*, Eastern White Pine *(P. strobus)*, Austrian Pine *(P. nigra)*, or Eastern Redcedar *(Juniperus virginiana)*. Spruce are very effective in large-area landscapes; Norway Spruce is outstanding. These trees show good tolerance to salt spray and adapt well to Midwestern soils. If there is any one spruce overused, Colorado Blue Spruce would highlight the list. Not only does *P. pungens* have many insect problems, but Cytospora canker often results in premature death of the tree. Colorado Spruce may be striking or outstanding in the Far West (dry), but in the humid Great Lake States, it should be used with caution. If spruce are desired in the home or small-area landscapes, then the many cultivars — *P. abies* 'Remonti,' 'Kosteriana,' or 'Nudiformis' — should be considered. **WTT**

WT&T

PRODUCTS

Easy-hitch snow plow reduces operator fatigue, contains a sealed valve for protection against snow and salt, and has a triple filter with built-in relief valves and by-pass system. Its hydraulics mount either directly to the hitch

frame, keeping hose lengths short and neat, or inside engine compartment to protect from the weather. Console sets neatly on the dash with only one wire entering the cab area. Model PV 200 (shown) is one in a line of plows from Swenson Spreader Co.

Write 701 on reader service card

Hydroconstant variable speed drive on pumps and fans offers an economical way to transform a relatively constant input speed into a variable output speed, thus conserving both energy and money. Many different models are available from the manufacturer, Peerless Pump.

Write 702 on reader service card

Owatonna Mfg. Co., Inc. has introduced its 441 Mustang loader which has a load rating of 1,400 pounds (diesel) and 1,325 pounds (gas). It comes with either a 107.4- cubic inch (1,760 cc) Perkins or a 44-horsepower (1,600 cc)

Ford engine that are both liquid-cooled. This compact machine digs, scarifies, lifts, carries, and plants.

Write 703 on reader service card

W-W Grinder Inc. has produced the W-W PS-325-3 power sprayer for spraying jobs, such as weed and insect control, lawn and garden fertilizing, and application of dormant oils and or-

ganic pesticides. Four wheels make it portable and easy to hand tow or hitch to garden tractors. Standard features are a no-rust polyolefin tank with a 25-gallon capacity and a 3-horsepower Briggs and Stratton gasoline engine. Its spray pattern reaches 25 feet.

Write 704 on reader service card

Power lawn aerator, model 1703, opens a narrow furrow with its tines to aerify an 18-inch swath. The machine, from Feldmann Engineering &

Manufacturing Co., Inc., has an automatic single lever hand release clutch for forward and neutral, fold down handle, lift grip, and weighs 60 pounds.

Write 705 on reader service card

Sand and salt spreader E-poke model TM 35, distributed in North America by Thomsen Products, Inc., is an ideal tow-behind spreader for sidewalks, bicycle paths, and pedestrian malls. The

44-inch wide machine incorporates a low center of gravity to help eliminate potential tip-overs and spreads a three-foot pattern with abrasives, salt, calcium chloride, or urea.

Write 706 on reader service card

Firewood splitter MX-400 from LaFont Corp. is designed with a tubular steel frame, large hydraulic oil reservoir, automatic or semi-automatic cycles, safety returns, a 13-inch wedge, 4-inch

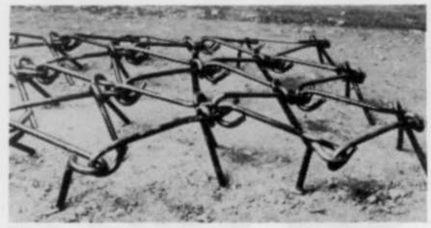
cylinder, and 24-inch wood lengths. It allows operation while still hooked to your car. Standard equipment includes taillights, safety chains, 1 7/8-inch ball hitch, and fenders.

Write 707 on reader service card

Bell Laboratories, Inc. has received EPA registration for its ZP Rodent Bait AG for control of ground squirrels, prairie dogs, voles, rats, and mice. It kills rodents on rangelands, rights-of-way, golf courses, parks, and other outdoor areas in one feeding. It applies by hand or broadcast by ground sprayers or aircraft.

Write 708 on reader service card

Flexible tine harrow from Fuerst Brothers, Inc. contains a series of seven 6-inch steel tine teeth, each 3½ inches long and linked together in a blanket-like effect to properly incorporate herbicides into the soil. It has no rigid



frame and can snake over the contours of the ground. Harrow comes in widths of 4½, 8, 10, 12, 16, 20, and 24 feet.

Write 709 on reader service card

EVENTS

The current issue of WEEDS TREES & TURF carries meeting dates beginning with the following month. To insure that your event is included, please forward it, 90 days in advance, to: WEEDS TREES & TURF Events, 757 Third Ave., New York, NY 10017.

14th Annual Delaware Turfgrass Conference, Hercules Country Club, Hercules Road, Wilmington, DE, **Dec. 1.** Contact Dr. William Mitchell, Plant Science Dept., University of Delaware, Newark, DE 19711, 303/738-2531.

Maintenance Symposium for ALCA, Washington Plaza Hotel, Seattle, WA, **Dec. 1-3.** Contact Associated Landscape Contractors of America, 1750 Old Meadow Road, McLean, VA 22102, 703/821-8611.

Turfgrass Conference, Rudder Conference Center, Texas A&M University, College Station, TX, **Dec. 1-3.** Contact Richard L. Duble, Soil & Crop Sciences Dept., Texas A&M University, College Station, TX 77843, 713/845-4826.

26th Annual Convention and Chemical/Equipment Exhibition, Las Vegas Convention Center, Las Vegas, NV, **Dec. 1-4.** Contact J.W. Eisele, 8823 N. Industrial Rd., Peoria, IL 61614, 309/691-2870.

Symposium on Surface Mining Hydrology, Sedimentology and Reclamation, Lexington, KY, **Dec. 1-5.** Contact Sue H. Hill, conference coordinator, University of Kentucky, College of Engineering, Anderson Hall, Lexington, KY 40506, 606/257-3971.

Minnesota Park Supervisors Association winter meeting, Washington County Park Dept., **Dec. 2.** Contact Thomas Feltl, M.P.S.A. Secretary, 8200 Wayzata Blvd., Golden Valley, MN 55427.

Ohio Turfgrass Conference and Show, Ohio Center, Columbus, OH, **Dec. 2-4.** Contact John R. Street, Cooperative Extension Service, The Ohio State University, 1827 Neil Ave., Columbus, OH 43210.

Kentucky ISA Chapter meeting, Holiday Inn North, Lexington, KY, **Dec. 8-9.** Contact Ervin C. Bundy, ISA Executive Director, 5 Lincoln Square, P.O. Box 71, Urbana, IL 61801, 217/320-2032.

New Jersey Turfgrass Expo '80, Cherry Hill Hyatt House, Rt. 73, Cherry Hill, NJ, **Dec. 8-11.** Contact Dr. Henry W. Indyk, General Chairman, Soils & Crops Department, P.O. Box 231-Cook College, New Brunswick, NJ 08903, 201/932-9453.

National Arborist Association 6th Annual Technical Seminar, Hyatt Regency O'Hare, Chicago, IL, **Dec. 9-10.** Contact Robert Felix, Executive Vice President, National Arborist Association, 3537 Stratford Rd., Wantagh, NY 11793, 516/221-3082.

Irrigation Association of New Jersey Annual Convention meeting, Hyatt House, Route 70, Cherry Hill, NJ, **Dec. 9.** Contact Irrigation Assn. of NJ, P.O. Box 128, Dayton, NJ 08810, 201/329-6003.

Ohio Turfgrass Conference & Show, Dayton Convention and Exposition Center, Dayton, OH, **Dec. 9-11.** Contact Dr. John Street, 1827 Neil Ave., Columbus, OH 43210, 614/422-2592.

Residential Landscape Design Short Course I, Fisher Auditorium, Ohio Agricultural Research and Development Center, Wooster, OH, **Dec. 10-12.** Contact Fred K. Buscher, Area Extension Agent-Landscape Horticulture, Administration Building, OARDC, Wooster, OH 44691, 216/262-8176.

21st Illinois Turfgrass Conference and Regional Show, Prairie Capital Convention Center, Springfield, IL, **Dec. 16-18.** Contact Illinois Turfgrass Foundation, P.O. Box 501, Urbana, IL 61801.

Surface Irrigation Short Course, San Luis Obispo, CA, **Dec. 16-18.** Contact The Irrigation Association, 13975 Connecticut Ave., Silver Spring, MD 20906, 301/871-1200.

Western Association of Nurserymen, Trade Show and 91st Annual Meeting, Hilton Plaza Inn, Kansas City, MO, **Jan. 4-6.** Contact Ed Gray, Executive Secretary, Western Association of Nurserymen, 2215 Forest Lane, Kansas City, KS 66106, 913/236-5203.

Maryland Turfgrass 81, Educational Conference & Trade Show, New Baltimore Convention Center, Baltimore, MD, **Jan. 5-7.** Contact John Strickland, President, 11412 Pulaski Hwy., White Marsh, MD 21162, 301/335-3700.

Indiana ISA chapter meeting, Atkinson Hotel, Indianapolis, IN, **Jan. 6-8.** Contact Ervin C. Bundy, ISA Executive Director, 5 Lincoln Square, P.O. Box 71, Urbana, IL 61801, 217/320-2032.

The Irrigation Association Short Course, Rochelle Park, NJ, **Jan. 6-8.** Contact The Irrigation Association, 13975 Connecticut Ave., Silver Spring, MD 20906, 301/871-1200.

Residential Landscape Design Short Course II, Fisher Auditorium, Ohio Agricultural Research and Development Center, Wooster, OH, **Jan. 7-9.** Contact Fred K. Buscher, Area Extension Agent-Landscape Horticulture, Administration Building, OARDC, Wooster, OH 44691.

Institute for Agricultural Irrigation, California State University, Fresno, CA, **Jan. 5-16.** Contact the Irrigation Association, 13975 Connecticut Ave., Silver Spring, MD 20906.

Midwestern ISA chapter meeting, Sheraton O'Hare, Rosemont, IL, **Jan. 11-13.** Contact Ervin C. Bundy, ISA Executive Director, 5 Lincoln Square, P.O. Box 71, Urbana, IL 61801, 217/320-2032.

North Carolina State University Agricultural Chemicals School, McKimmon Center for Extension and Continuing Education, Raleigh Campus, **Jan. 12-13.** Contact A.D. Worsham, Chairman, Program Committee, Department of Crop Science, Box 5155, Raleigh, NC 27650.

Southeastern Pennsylvania Turf School & Trade Show, Westover Country Club, Jeffersonville, PA, **Jan. 13-14.** Contact Dr. William H. White, Philadelphia County Cooperative Extension Service, SE Corner Broad & Grange Streets, Philadelphia, PA 19141, 215/424-0650.

27th Rocky Mountain Regional Turfgrass Conference, Lory Student Center, Colorado State Univ., Ft. Collins, CO., **Jan. 15-16.** Contact Jack D. Butler, Dept. of Horticulture, Colorado State Univ., Fort Collins, CO 80523, 303/491-7070.

The New Hampshire Turfgrass Conference, Sheraton-Wayfarer Motor Inn, Bedford, NH, **Jan. 15-16.** Contact Dr. John M. Roberts, Extension Specialist, Turf, Dept. of Plant Science, Nesmith Hall, Univ. of N.H., Durham, NH 03824, 603/862-1200.

Mid-America Horticultural Trade Show, Hyatt Regency Hotel, Chicago, IL, **Jan. 16-18.** Contact Mid-Am, 4300-L Lincoln Ave., Rolling Meadows, IL 60008, 312/359-8160.

New York Arborists ISA chapter convention, Marriott Inn, East Syracuse, NY, **Jan. 18-20.** Contact Margaret Herbst, Executive Secretary, New York State Arborists, ISA Chapter, 230 Park Avenue, New York, NY 10017.

The Irrigation Association Short Course, Kansas City, MO, **Jan. 20-22.** Contact the Irrigation Association, 13975 Connecticut Ave., Silver Spring, MD 20906, 301/871-1200.

Western Pennsylvania Turf & Grounds Maintenance School & Trade Show, Howard Johnson Motor Lodge, Monroeville, PA, **Jan. 20-22.** Contact Philip L. Sellers, Allegheny County Cooperative Extension Service, 311 Jones Law Building Annex, 311 Ross Street, Pittsburgh, PA 15219, 412/355-4275.

Southern Weed Science Society 34th Annual Meeting, Dallas Hilton Hotel, Dallas, TX, **Jan. 20-22.** Contact John R. Abernathy, Secretary-Treasurer, Texas Agricultural Experiment Station, Route 3, Lubbock, TX 79401.

Virginia Turfgrass Conference and Trade Show, John Marshall Hotel, Richmond, VA, **Jan. 20-22.** Contact John R. Hall, III, Extension Specialist, Turf, VPI & SU, 426 Smyth Hall, Blacksburg, VA 24061, 703/961-5797.

The Land Reclamation Report

Texas gets approval of state reclamation plan

Texas has become the first coal mining state to receive approval of its reclamation plan from the Interior Department's Office of Surface Mining OSM.

Approval of the state plan submitted by the Texas Railroad Commission will entitle Texas to request up to $1.7 million, said OSM Director Walter N. Heine. This is 50 percent of all reclamation fees collected from active coal mining operations in the state since Oct. 1, 1977, when the fee system went into effect, through Sept. 30, 1979. Texas can receive the funds after OSM has reviewed and approved the specific projects proposed.

"The $1.7 million now available was reserved for reclaiming abandoned coal mine lands in Texas until the state received approval of both its coal mining regulatory program and its reclamation plan," said Heine. "These conditions are contained in the Surface Mining Control and Reclamation Act of 1977."

The TRC reclamation plan for abandoned coal lands extends through 1982, with total expenditures expected to total more than $5.5 million in 1981 and 1982. When all abandoned coal lands are reclaimed, under a priority system in the Act, the TRC hopes to use reclamation funds for other non-coal related mining reclamation purposes.

Ranking study will help pick mining sites

A method of selecting sites for coal surface mines in areas where protection of environmental and cultural values is especially important will be developed for the Montana Crow Indian Reservation.

The Bureau of Mines has awarded a $70,000 contract to Harvard University to rank the resources—economic, like coal and water, cultural, and environmental—of the area. The Bureau feels that such a plan would be widely useful to the mining industry in areas where sensitive factors should be considered before mining.

The 69,000-acre coal reserve area of the reservation has an estimated six billion tons of coal reserves. It is also a breeding ground for prairie dogs, deer, elk, hawks, golden eagles, and other wildlife; and contains tribal burial grounds, ruins, and rock art sites.

Coal production will reach 1.25 billion tons

Domestic coal production should increase by 62 percent over the next 10 years, according to a study by the Economics Committee of the National Coal Association.

The U.S. coal industry, which currently is able to produce at least 100 million tons more each year than is being used, will see production reach 1.25 billion tons annually by 1990 compared to a projected rise to 1.17 billion tons of consumption.

Major factors cited by the Economics Committee as affecting future growth include increased demand for electricity and steel, availability of nuclear power, supply and price of oil and natural gas, impact of environmental regulations, growth in U.S. coal's export market, and the rate of development of coal-based synthetic fuels.

Report shows advances in mine reclamation

Improvements in seven areas of surface coal-mine reclamation—from topsoil rock removal to the transplanting of vegetation—are summarized in a report of the Bureau of Mines.

The 80-page report consists of seven articles on recent advances in reclamation techniques, machinery, and research. It is illustrated with photos, tables, and diagrams.

Single copies of Information Circular 8823, "Surface Coal Mining Reclamation Equipment and Techniques, Proceedings: Bureau of Mines Technology Transfer Seminars, Evansville, Ind., June 3, 1980, and Denver, Colo., June 5, 1980," can be obtained free from: Publications Distribution, Bureau of Mines, 4800 Forbes Ave., Pittsburgh, Pa. 15213, 412/621-4500, ext. 342. Requests should specify the complete title and number of the report.

WT&T CLASSIFIEDS

Rates: All classifications 65¢ a word. Box number, $1. All classified ads must be accompanied by check or money order covering full payment. Mail ad copy to: Dawn Anderson, WEEDS, TREES & TURF, 1 East First Street, Duluth, MN 55802.

When answering ads where box number only is given, please address as follows: Box number c/o WEEDS TREES & TURF, Classified Ad Department, 120 West Second Street, Duluth, MN 55802.

SEEDS

SOD QUALITY SEEDS: Adelphi, Glade, Cheri, Nugget, Merion, Fylking, Majestic, Baron & Touchdown bluegrasses, also fine fescues. Manhattan ryegrass. Custom mixing available. Michigan State Seed, Grand Ledge, Michigan 48837. Phone (517) 627-2164.

USED EQUIPMENT

SPRAYER, 1979 BEAN Turf Model 1010T, 150 gallon stainless, 500 psi, 10 GPM, flotation tires, five hours, $700 below cost. (712) 623-9372, Rand Wilson, Box 56, Red Oak, IA 51566.

FOR SALE: 1979 FMC sprayer. 500 gal. tank, 35 GPM pump. MANY EXTRAS, $2,000 (Below Retail) Call Now! (804) 625-2277.

1978 WOODCHUCK BRUSH CHIPPER, six cylinder Ford 300 engine, only 170 hours, excellent condition. Call (704) 366-4163; 366-3032.

STUMP GRINDER, Vermeer 665, $8,300. Limb chipper, Olathe Model 172, $2,500. (804) 420-3010.

AERIAL BUCKETS, call Aerial Hydraulic Equipment, Essex, Conn. (203) 767-1636 — For brush chippers, Vermeer stumpers, sprayers, Hydro-Ax's, log loaders available for immediate sale, call P.C. Gould Sales Company, Plains Road, Essex, Conn. 06426. (203) 767-1636.

BRUSH CHIPPERS, used Bean sprayers, Model 10 Vermeer stumpers, Hydro-Axs and bucket trucks. Lease or for sale. Large inventory available. Call or write P.C. Gould Sales Company, Plains Road, Essex, Conn. 06426. (203) 767-1636.

FOR SALE: Ryan Greensaire II Turf aerator, model 544801, new condition, used once since purchase in 1979. D.E. Price, Mgr., Pinecrest Country Club, Pelham, Georgia (912) 294-8525.

FOR SALE: 110' XHD Garland crane mounted on 1971 F-8000 Ford, new Caterpillar diesel engine. Immaculate condition, $42,000.00 Colored photos on request. Eastcoast Crane, Inc., (201) 922-9393.

FOR SALE: 78 inch Big John tree mover, serial 32 in good condition, original owner. Trees, Inc. (517) 627-9155.

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HI-RANGERS AERIAL BASKETS 65', 57', and 53'. Skyworkers aerial baskets 65', 50', 40'. Vermeer stump cutter 1560, 6. Vermeer tree spade 66, TS 44. Asplundh bucket and brush chippers. Bean sprayer, 9 ton trailer. Parkway Tree Service, 12026 W. Cherry, Wauwatosa, Wisc. 53226. (414) 257-1555.

FOR SALE: 1974 TS44T Vermeer tree spade mounted on 1974 1 ton 4 wheel drive truck. Both like new, $11,800.00 Asplundh cutter head and P.T.O. assembly for a truck-mounted chipper, $1300.00. 1 Asplundh 12" chipper needs a motor and clutch, $1300.00. Edwards Tree Service, 49090 Cooper Foster Pk., Amherst, Ohio 44001.

ANDERSON SERIES "E" rotary rock picker, PTO drive, 1976 model, like new. $4,500.00 or will consider trade. Contact: Supt. of Parks, Naperville Park District, 421 W. Martin Avenue, Naperville, Illinois 60540 (312) 420-4230.

STUMP CUTTER, Vermeer 2460, $6,900.00; 1970 Chevrolet chipper, truck and Asplundh chipper. Both for $10,500.00; 4 inch Homelite water pump, $1250.00. All in excellent condition. P.O. Box 2116, East Peoria, IL 61611. Phone (309) 699-7920.

SKYWORKER — 1044A, 55' mounted on 1969 Ford 700 series, $11,000.00. (317) 289-0579 after 6:00 P.M., Muncie, Indiana.

FOR SALE: Two 1972 Baker-York forklifts, towable in good condition, $7,500.00 each. Contact: Big Valley Sod Farms, R.R. 2, Calhan, Colorado 80808. (303) 683-2599.

FOR SALE: 15 hp, 3 phase, 208 volt electric motor with 200 GPM Berkeley pump. 2x3. Valley Green Sod Farm, 1996 Sedivy Lane, Rapid City, S.D. 57701. (605) 348-6999.

1977 BOWIE 350 gallon hydro-seeder with bean pump and all attachments and hoses. $5,000.00. Mark J. Trusty, (816) 263-2562.

REAL ESTATE

DELAWARE — 101 acre sod farm. Real estate, plus equipment included. Grosses $300,000. Contact Jerry Bellini, 4810 Concord Pike, Wilmington, DE. (302) 478-0887.

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BUCKET TRUCK and 1,000 gallon hydraulic tree spray rig. Tamke Tree Experts, Inc., Martinsville Road, Liberty Corner, NJ 07938. (201) 647-3537.

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LIQUID FERTILIZING and tree removal company established 1974 with major growth each year. Year round business located in the western suburbs of Chicago. Will divide. (312) 584-5753.

LAWN SPRAYING BUSINESS. Established Ohio liquid lawn care business for sale. 5000 accounts. Six figure selling price. Owner could assist buyer. Write WTT Box 255.

FOR SALE: Lawn maintenance business. Working partner or buyer wanted for $100,000 gross mowing operation. $10,000 minimum investment. Write WTT Box 256.

WELL ESTABLISHED CALIFORNIA (L.A. area) tree service. Owner retiring, cash or terms. Send inquiries to: Pacific Coast Tree Service, P.O. Box 147, Encino, CA 91316 or call (213) 784-3301.

HELP WANTED

LANDSCAPE SUPPLY MANAGER. Large commercial landscape contracting firm is taking applications for a person to handle the purchasing of plants and materials for landscape projects in the Baltimore/Washington area. Experience is necessary for this management position. Send resume and salary requirements to: J. Landon Reeve IV, President, Chapel Valley Landscape Company, 3275 Jennings Chapel Rd., Woodbine, MD 21797. An Equal Opportunity Employer.

A PERSON with strong educational and experience background in landscape horticultural sales for landscape maintenance. This individual must be a self-starter, be knowledgeable in landscape maintenance and be able to communicate this knowledge to our clients and prospects with a high degree of credibility. Interested prospects should be willing to locate in either the Houston or Dallas, Texas area. For consideration, send qualifications and resume to: Maintain Incorporated, 2549 Southwell, Dallas, TX 75229. Attention: Carl McCord, President.

FORESTER WITH UTILITY DISTRIBUTION line clearance experience. A progressive national consulting firm requires a graduate forester with a minimum of 4 years experience in all phases of utility line clearance tree trimming. Desirable experience would include programming, budgeting, crew organization, supervision and records. Must be a self-starter with special ability to organize complex data. Must be able to present ideas effectively in written and verbal reports. Opportunity for advancement. Good benefits. Salary open. Write WTT Box 253.

FOREMAN POSITION OPENINGS with leading landscape firm in Portland, Oregon. We are seeking experienced, motivated, well-groomed supervisors to manage landscape, irrigation and/or maintenance crews. Year-round work, outstanding benefit program with retirement and profit share plan, and excellent opportunity for advancement. Send resume to P.O. Box 230288, Tigard, Oregon 97223.

CAREER OPPORTUNITY: Midwest multi-store chemical lawn care company needs managers. $16,000 minimum first year, bonus program, sales commissions, excellent benefits. You must: be willing to relocate, have management experience, be turf knowledgeable. Mail resume to WTT Box 252.

WANTED — SHOP FOREMAN to take over shop building and maintaining hy-rail truck spray equipment. Must have welding, cutting and fabrication experience. Good mechanical aptitude. Salary commensurate with experience. Reply to Asplundh Railroad Division, Blair Mill Road, Willow Grove, PA 19090. Attention: Frank Grant.

ADVERTISING SALES POSITION AVAILABLE — Pest Control Magazine is seeking an aggressive individual with experience in and commitment to the pest control industry, midwest territory. Motivation, creativity and marketing ability a must. Space sales experience desirable but not required. Salary plus commission, all expenses and a good benefit program. Reply to: Cheryl C. Lyons, The Harvest Publishing Co., 757 3rd Ave., New York, NY 10017. An equal opportunity employer.

HELP WANTED — Sales person NJ, PA, MD & DE area to demonstrate & sell commercial riding lawn mowers, etc. Zimko Management Company, Division of Crestwood Village, Inc., P.O. Box 166, Whiting, NJ 08759.

MISCELLANEOUS

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ADVERTISERS

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Debbie Gutierrez
Assistant Manager, Domestic and International Sales, checks Baron production and distribution from Lofts' Great Western Division in Oregon.

Vanessa Jensen
Assistant Manager and Golf Course Sales, Lofts/Maryland, administers distribution and customer service in the Mid-Atlantic states. (Shown here calling on Angie Cammarota, Superintendent of Hobbits Glen Golf Course, Columbia, Maryland.)

Andrea Landry
Executive Sales Coordinator, supervises Lofts' nationwide customer service, coordinating operations coast to coast.

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