You've probably always used Bean pumps. Now you can use our lawn sprayers.

For years, FMC has been building the very best in turf pumps. Now we've designed a complete turf spraying line. The FMC model D010 lawn sprayer. The line features a truck type mount with a spray tank available in 300, 600 or 1200 gallon capacities.

And the pump is perfect for turf spraying. It delivers up to 10 gallons per minute at pressures up to 500 psi. Plus, thanks to its new relief valve, you can utilize low pressure settings without pressure buildup.

PTO power is standard but a gas engine is available. It's air cooled and features an electric starter. Optional equipment? We've got plenty. Like manual or electric hose reels, rubber or plastic hose, and a stainless steel hand gun specially designed for turf work.

Like to get your hands on one? See your FMC dealer today. Or write for our free brochure. FMC Corporation, 5601 E. Highland Dr., Jonesboro, Arkansas 72401.

Manufacturers of sprayers, pumps, mowers, and tillage and harvesting equipment.

FMC Jonesboro, AR • Ripon, CA
Ocoee, FL • Minden, LA

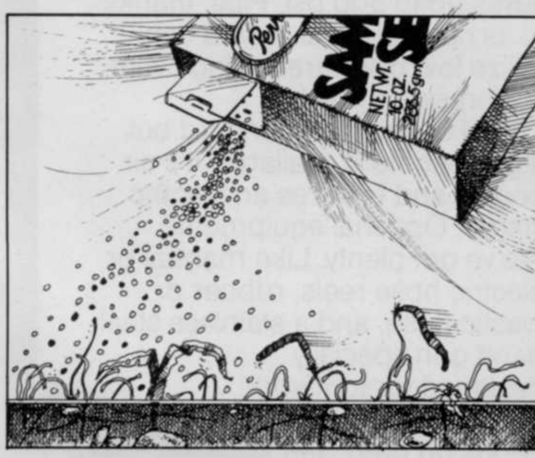
The 2-Step Turf Renewal Plan with Roundup® and Pennfine.

One. Two.

Spray Roundup® on the turf area to be renewed.

With just one application of Roundup® herbicide by Monsanto, you can control or destroy most unwanted vegetation. Including stubborn intruders like annual bluegrass, bermudagrass, quackgrass, johnsongrass, tall fescue, and kikuyu grass.

In a matter of days, Roundup circulates throughout these weeds. Even into the below-ground roots, destroying the entire plant. Yet Roundup has no residual soil activity. That means there is no injury to new seedings planted after application.



Spread Pennfine Perennial Ryegrass seed over the area treated with Roundup.

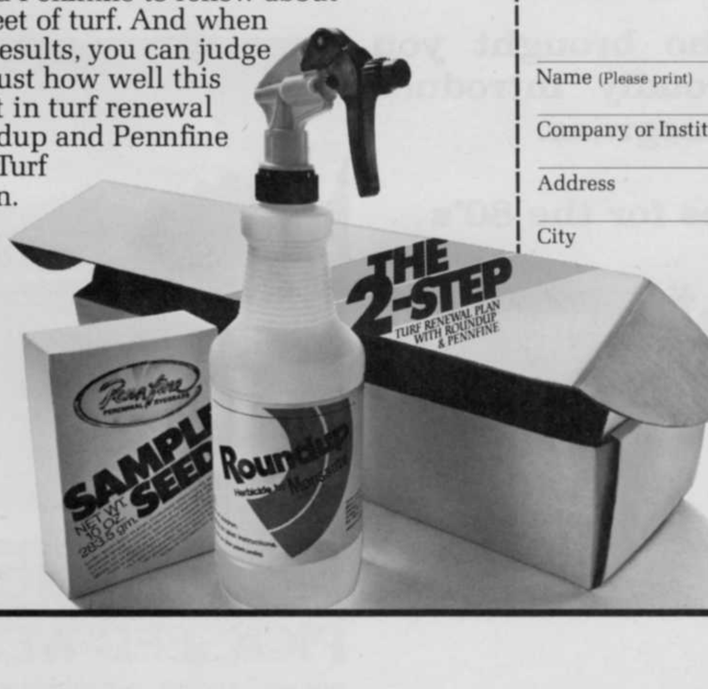
After applying Roundup, seed with fast-growing, fine-leafed Pennfine Perennial Ryegrass. Pennfine was developed by Dr. Joe Duich at Pennsylvania State University. Pennfine has been proven to germinate quicker, grow denser, and resist disease better than traditional ryegrasses. And it penetrates compact soil, sending its roots to depths of 12 to 18 inches. These qualities make Pennfine an excellent choice for turf renewal and help to explain why it's used by turf professionals from coast to coast. In a short time, you'll see the proof for yourself.

PENNFINE PERENNIAL RYEGRASS HAS BEEN ACCORDED U.S. PLANT VARIETY PROTECTION CERTIFICATE NO. 7200019.

Free.*

***It will have cost you nothing to see how dramatically the 2-Step Turf Renewal Plan can improve your turf.**

Our free kit contains enough Roundup and Pennfine to renew about 200 square feet of turf. And when you see the results, you can judge for yourself just how well this new concept in turf renewal works. Roundup and Pennfine —the 2-Step Turf Renewal Plan.



Put Our Free Kit to the Test.

Find out for yourself how effectively these two superior products work together in a simple turf renewal program. All it will cost you is the price of a stamp.

Name (Please print) __________

Company or Institution __________

Address __________

City ______ State ____ Zip ____

Send this coupon to:
Turf Renewal Plan,
Box 923, Minneapolis,
MN 55440

Note: this offer is restricted to turf professionals—those whose livelihood depends on the maintenance of quality turf. *Limit one per company or course.* Offer void where prohibited by law.

WEEDS TREES & TURF

Just fill in card...(all items must be completed before inquiries can be processed).
Check one box in each category

1 Check one that best describes your primary business/industry:

- 11 ☐ Aerial Applicator
- 12 ☐ Airport Grounds Management
- 13 ☐ Apartment/Condominium Grounds Manager
- 14 ☐ Athletic Field/Sports Complex Mgr.
- 15 ☐ Arborist/Tree Specialist
- 16 ☐ Cemetery Grounds Care
- 17 ☐ Christmas Tree Farm
- 18 ☐ Conservation District Agent
- 19 ☐ Contract Chemical Applicator
- 20 ☐ County Extension Agent
- 39 ☐ Dealer or Distributor
- 49 ☐ Erosion Control Specialist
- 59 ☐ Forestry/Forester
- 24 ☐ Garden Center
- 25 ☐ Government Grounds Maintenance
- 26 ☐ Golf Course
- 27 ☐ Hospital or Nursing Home Grounds Mgr.
- 28 ☐ Industrial or Office Park Grounds Mgr.
- 29 ☐ Land Reclamation Specialist
- 30 ☐ Landscape Architect
- 69 ☐ Landscape Contractor
- 79 ☐ Lawn Care Specialist
- 89 ☐ Lawn Maintenance Service
- 34 ☐ Nursery/Wholesale Grower
- 35 ☐ Parks Management
- 25 ☐ Roads Right-of-Way Mgr.
- 26 ☐ School/College/University Grounds Mgr.
- 27 ☐ Seed Grower
- 39 ☐ Sod Grower
- 40 ☐ Utility Co., Railroad Right-of-Way Mgr.
- 28 Other ____________

2 Check one which best describes your buying responsibility:
21 ☐ Purchase 22 ☐ Specify or recommend purchases

3 What is your estimated annual expenditure for each of the following:

3A/ Chemicals (for weed, disease and pest control)
31 ☐ Up to $1,000 36 ☐ $15,000 to $30,000
32 ☐ $1,000 to $5,000 37 ☐ $30,000 to $50,000
33 ☐ $5,000 to $15,000 38 Other________

3B/ Fertilizers (All Formulations)
51 ☐ Up to $5,000 56 ☐ $30,000 to $50,000
52 ☐ $5,000 to $15,000 57 ☐ $50,000 to $70,000
53 ☐ $15,000 to $30,000 58 Other________

3C/ Equipment (for turf, tree and grounds care)
61 ☐ Up to $10,000 66 ☐ $60,000 to $100,000
62 ☐ $10,000 to $30,000 67 ☐ $100,000 to $150,000
63 ☐ $30,000 to $60,000 68 Other________

3D/ Irrigation (Installation and replacement parts)
71 ☐ Up to $5,000 76 ☐ $30,000 to $60,000
72 ☐ $5,000 to $15,000 77 ☐ $60,000 to $100,000
73 ☐ $15,000 to $30,000 78 Other________

3E/ Plant Materials (Trees, Ornamentals, Seeds, Sod, etc.)
81 ☐ Up to $5,000 86 ☐ $30,000 to $60,000
82 ☐ $5,000 to $15,000 87 ☐ $60,000 to $100,000
83 ☐ $15,000 to $30,000 88 Other________

91 First Initial | Middle Initial | Last Name

92 Your Title

93 Company Name

94 Mail To:

95 City | State | Zip Code

96 Phone: Area Code ☐☐☐ No.: ☐☐☐☐☐☐☐

Address shown is:
98 ☐ Business
99 ☐ Home

97 Signature: ______________________ Date________

Do you wish to receive/continue receiving Weeds Trees & Turf? ☐ Yes ☐ No

4 Please estimate the following:
41 # acres you maintain/manager ____________ acres
42 Lake or pond water you manage # ________ acres feet

5 **For more information** about products displayed in this issue, print the reader service number in the spaces provided below and block out A, B, C, or D for specific information needed.

61 [a] Need Catalog literature
62 [b] Need more price Info
63 [c] Interest in Purchasing
64 [d] Have specific problem—have salesman call.

JUNE 1980 (Expires in 60 days)

reader service card

Use this card to obtain more information...fast.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 2675 CLEVELAND, OHIO

POSTAGE WILL BE PAID BY ADDRESSEE

WEEDS TREES & TURF

9800 Detroit Ave.

Cleveland, Ohio 44102

B

Homeowners around Midwest lakes often form an association and then contract an applicator to do the work. A group of researchers recently started its own Midwest Aquatic Plant Management Society and is trying to get affiliation with the national organization. Its main objective, says Lembi, is to exchange technical information on aquatic plant management and involve the commercial applicator.

The Northeast, where aquatic weeds are fortunately not a severe problem, does not have a formal approach to the few weeds that find their way into lakes and rivers.

The North Atlantic division of the Army Corps has recently studied the water chestnut, Eurasian watermilfoil, and yellow floating heart in Lake Champlain and started a 10-year program with mechanical harvesters, says Dr. Robert Pierce of the division. New York has completely cut chemical control and is studying biological controls.

Managers, both researchers and applicators around the country, have begun to share expertise about the unique aquatic environment and the plants they want to control. Although problems vary throughout the states, this exchange crosses borders as freely as rivers. Florida's study on watermilfoil will help Washington, and Arkansas's experiments with the triploid should benefit California. Today's weed problems necessitate a broad-based diversified attack.

Aquatic plant management in many regions is just emerging from its embryonic form. For others who have been dealing with severe problems, the science, profession, and solutions are still in the early stages of development. Says Dr. Burkhalter, "Aquatic plant problems and control technology are rapidly changing. The future of aquatic plant management belongs to individuals who will do likewise." **WTT**

Mechanical Options *from page 20*

from page 20

additional oxygen to the water through splashmaking and wavemaking. The company makes various models for different applications. (Write **202** on reader service card).

Clean-Flo Laboratories, Inc., Hopkins, MN, manufactures an aeration system called the "Fish-Air." Based on the principle of multiple inversion, it floats the bottom water up to the surface to be oxygenated by the energy in the wind. Through this multiple inversion, Fish-Air rolls a pond or lake over and over so every drop of water repeatedly comes to the top.

The system consists of an oilless 1/3-horsepower, 115-volt, single-phase compressor, necessary fittings, a spare set of air filters, a location float, a microporous diffuser, and easy instructions. It can purify an acre of water 6 feet deep three to four times a week while using the electricity equivalent to a 250-watt light bulb. Fish-Air works in all types of water bodies. (Write **203** on reader service card).

Dredgers

Dredging can remove existing rooted plants and nutrient rich sediments and also increase water depths. If the bottom is properly contoured, underwater weed growth can be reduced or eliminated. Large hydraulic dredges may be used on large bodies of water.

The Water Vac Dredge, made by Aztec Development Co., Orlando, FL, removes both rooted weeds, such as hydrilla, by the roots and tubers, and floating weeds, such as water hyacinth. It can also deepen canals, remove shoals, and do work normally involved in dredging. Because of its nonturbidity and ability to ingest and mulch weeds, this machine can also take out deposited runoff, sediment, hazardous materials, and muck down to the original bottom and safely enclose these materials in pipes for transportation to remote areas.

The machine cuts an 8 foot wide by 18 inch deep row of weeds, and can operate to a depth of 10 feet, 6 inches. It is 30 feet, 2 inches long, 8 feet wide, and weighs 16,000 pounds. It can hold 360 gallons. (Write **204** on reader service card).

Dredgeast, Inc., New Canaan, CT, makes the Mud Cat dredger to remove mud, muck, silt, sand, chemical sludges, and industrial wastes from water bodies without severely disturbing the water. A well-muffled diesel engine, capable of pumping 2,000 gallons per minute of liquid with solid concentrations of up to 20 percent, powers it. The cutter head houses a spiral auger with twin horizontal screws which enables it to make a precise cut of up to 15 feet deep and 8 feet wide.

Mud Cat can remove 120 cubic yards of solids per hour. It maneuvers around stumps and other obstructions. It is 30 feet long by 8 feet wide and draws only 21 inches of water. (Write **205**).

Miscellaneous

Every piece of equipment used to control weeds is not mechanical yet the unique nature of this material defies classification into a large listing. One of these is Aquascreen, a closely woven, vinyl-coated screening material that is inert, very strong, and durable. Menardi-Southern Corp., Augusta, GA, manufactures it.

When pinned to the bottom of a pond, this material controls weeds by compression and by reducing 50 to 60 percent of the light necessary for growth. The weeds covered will decompose over a four to six week period, while life continues back and forth through the screen. It transfers to another site by just pulling the pins, moving it, and replacing it. (Write **206**).

Aquashade, Inc., Eldred, NY, also has a solution to the problem of aquatic weeds—Aquashade. This liquid concentrate turns water a beautiful blue to cut off the sunlight that weeds and algae need for growth. Water remains non-toxic to fish, wildlife, and people, making it immediately safe for swimming. It is a continuing control after application, stopping excessive algae and weed growth for a period as long as the color stays.

Aquashade is best applied at a rate of 1 gallon per acre of water four feet deep. Application remains in the water dependent on length of growing season, water flow rate, fertility, and clarity. (Write **207**).

MANAGING TREES TO REDUCE DAMAGE FROM LOW-LEVEL SALINE IRRIGATION

By E. P. Van Arsdel, Associate Professor,, Forest Pathology, Texas A&M University, College Station, Texas

Accumulation of salts in shade trees from low-level saline irrigation water (which is absorbed by the roots and left behind in the leaves from evaporation and transpiration) is common in areas where irrigation is used to supplement the natural rainfall. It is more common where most of the water taken up by the trees is from irrigation. Chloride builds up in the leaves where the water contains 40 ppm chloride. This is common in Bryan-College Station, Texas, and in areas to the west and north. Calcium and sulfate in the water tend to reduce the amount of damage from the sodium and chloride.

The damage to vegetation from low levels of salt is occurring with water usually considered safe for irrigation. The water in Bryan and College Station is classed as fresh or slightly saline (Texas Dept. Health 1977, Winslow and Kister 1956), but evaporation from the leaves causes chloride to build up in them to well above toxic levels. The sodium also builds up to high levels in the soils. The soils themselves contribute to the problem because their impermeability prevents the salts from being leached away, and the abundant montmorillonite clay has a great capacity to absorb sodium.

The salinity standards for waters have been set by their content of total dissolved solids (Winslow and Kister 1956), but the water in Bryan, College Station, and Texas A&M University has an uncommonly high proportion of its dissolved solids in sodium and chloride (Tex. Dept. Health 1977). Carbonate is the only other abundant ion.

Another factor contributing to the commonness of saline injury to shade trees is the use of unnecessarily large quantities of irrigation water by the homeowners in irrigating their lawns. They often use many times the amount of water a farmer would use to irrigate his crop to bring it to maturity.

Some owners whose trees have declined or died from salt accumulation from the irrigation water are reluctant to modify their management practices; but unless the practices are changed, after the trees have died the conversion of St. Augustine grass to more salt tolerant Bermuda grass might occur. This grass might then give away to more salt tolerant weeds, and then bare spots might appear in the lawn. Such shifts may portend a local desertification of the lawn through sodium accumulation and the advanced development of black alkali. Not responding to the declining and dying trees and the shifts in vegetation by changing management practices can lead to greater problems in the future. A picture on page 626 of the November 1979 National Geographic shows advanced cases (Gore 1979).

Diagnosis

Salt in trees may come from many sources, and it has been said that the sources of salt, whether from the ocean, highway deicing, or saline soils are not important (Dirr 1976). However, there are differences in the amount of salt taken up by the leaves

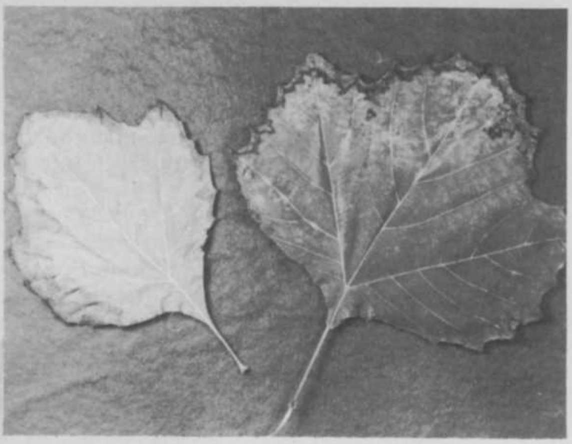
or the roots. For example, southern Magnolia, which has a thick glossy cutin on its leaves and does not readily absorb airborne ocean salt sprays, does readily absorb salt in the irrigation water through its roots. It is relatively more resistant to salt in the air than it is to salt in the soil solution. The gross symptoms of dieback on a post picture (p. 27) shows oak absorbing salt from low-level saline irrigation applied to a golf green.

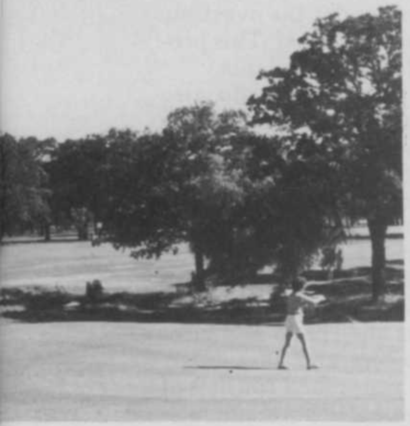
The symptoms of salt injury are difficult to distinguish from symptoms of infection with the oak decline fungus (*Cephalosporium diospyri*). Both maladies produce thin crowns through which skylight is readily seen, both cause dieback. At times the salt produces a brown or gray peripheral injury of the leaves. In cases where the spring rains were adequate and irrigation was delayed until summer, a serial reduction in leaf size has occurred. Full sized leaves were produced in the spring, but each new set of leaves produced was smaller than the last one, and in the fall the last leaves formed were truly tiny dwarfs.

Comparative leaf symptoms of some maladies on oaks, including salt, are illustrated in another paper (Van Arsdel 1978). Salt injured trees seem to be more subject to wind breakage, and insects seem to prefer to feed on them.

Usually the separation of the fungus decline from the salt injury requires culture isolation tests for the fungus, salt (chloride) tests for the leaves, and soil tests for alkalinity and sodium content. Both maladies produce similar physiological drouths and they often occur in the same tree at the same time. Where they occur together the two kinds of physiological drouth supplement each other.

Killing the vascular wilt fungus with a systemic





Post oak by golf green exhibiting saline irrigation decline.
Sycamore leaves with perimeter scorch and shape distortion caused by saline low-level saline irrigation.

fungicide makes the trees seem to recover, with larger leaves and crown thickening, but if the saline irrigation continues, the trees continue to die back and decline. The dwarfed leaves have been found with salt injury in the absence of the decline fungus, and the trees have had dieback and eventually death from the salt, but we have not had cases in which the saline irrigation was terminated to see what effect this would have on the *Cephalosporium* infected trees. We now have a case where we can terminate the saline irrigation by using unsoftened water where salt-softened-water was the source of the sodium and chloride, and this should disclose the symptom change where the salt water intake is reduced and the *Cephalosporium* remains undisturbed.

An important part of the diagnosis for salt injury is the testing of the irrigation water for its salt content. This can be done with chloride testers (titration) or spectrophotometrically for the sodium, but in Texas all of the public water supplies are regularly tested by the State Board of Health. The results are available upon request and are also published in a book. Often the slightly saline water supply is the only water available for irrigation, and the problem is to manage the irrigation when the only supplies are saline. Some representative Texas water supplies were listed with their salt contents in my recent paper (Van Arsdel 1979).

Another aid to diagnosis of saline irrigation is the order in which the trees and shrubs show injury or die. A table of relative susceptibility is appended. This list should aid in diagnosis and in suggesting substitute plants where saline irrigation can not be avoided. This rating list carries the salt tolerance level beyond the least tolerant plants listed in the USDA Ag. Hndbk. 60, and some of our most "resistant" plants are among their "least tolerant" species. Our listing is in closer agreement with another list of salt tolerance which summarizes observations of many authors of the salt tolerance of shade trees to blown and splashed deicing salt along roads in the northeast (Uirr 1976). Together the three lists indicate that shade trees are generally less salt tolerant than field crops.

Mode of action

Salt is sodium chloride, and its solutions contain these ions independently. They act in different ways as they cause the decline of trees absorbing the salts. The chloride does not reach a high level in the soil — 50 ppm is the highest I have measured — and usually there has been less than 20 ppm. The chloride builds up to high levels in the leaves of the trees. There is usually dwarfing at levels of 1,000-3,000 ppm chloride in the leaves, and there are usually scorch symptoms at more than 3,000 ppm. I have found as much as 35,000 ppm in living leaves, although more than 6,000 ppm is exceptional. The chloride concentrations above 3,000 ppm kill tissues, and cause the perimeter scorch, but chloride is mobile in the plant, and the level often decreases during rainy weather.

Sodium builds up to high levels in soils. Levels of 2,000 ppm sodium in the soil are fairly common. This is usually indicated by extreme alkalinity (pH 8.5-9.0). The sodium builds up to the highest levels where montmorillonite clay in the subsoils prevents percolation. This clay is the fraction of the soil that absorbs the sodium and holds it. The sodium disperses the clay causing the soil to lose structure and to become hard, alkaline, and impermeable in a condition known as black alkali. Trees can not grow in a soil in this condition.

Management program to minimize damage

Management of low-level salinity irrigation problems presented here involves changing the source of water, watering less, and making physical and chemical modifications to the soil. Often alternative sources of water are not available, but most homeowners can water less. Locally, the Lufkin soil on Yegua formation parent material, permits no internal drainage through the claypan or the deep layers of clay and shale under it and thus prevents leaching, but some leaching can occur over the surface, especially in winter when there is abundant rain and low evaporation. Each of these management alternatives is considered below .

Normal procedures to manage crops with saline irrigation are (1) to grow salt tolerant crops, (2) to avoid clay in the soils, and (3) to provide excellent drainage to permit leaching (Boyko 1968). None of these alternatives are available to us. We are working with plant species more susceptible to salt than those generally considered in the saline soil and irrigation literature (Richards 1954), and with plants which are already growing on the site with no chance of moving them. The soils we are concerned with must be utilized in place, and have high montmorillonite clay contents in both the soil and subsoil. These clay soils originally had no internal drainage, but the addition of salt through saline irrigation makes them even less permeable to water. Often they are held to certain levels by streets, curbs, and gutters that were laid out with no plan for drainage.

Change the water source:

If water of very low salinity is available, then using it is a good solution. Some examples follow.

Rain barrel: Potted house plants, greenhouse plants, or any other plants under roofs and not receiving rainfall usually have salt injury. Using rainwater is a very good solution to the problem. If you have many plants or a long dry season, many barrels may be required (I use 4). A major problem is the mosquitoes who lay eggs and reproduce in the water in the barrels. Goldfish eat the mosquitoes and wigglers readily, but the water must be aerated for them to survive, and as you use up the water supply, then what do you do with the fish? The goldfish are cheap enough that you can let them die and keep replacing them, but since I am soft hearted, I find myself putting a good deal of effort into maintaining the fish. A fishpond with a relatively larger surface area makes a better reservoir than rain barrels if you want to use fish. However, you can never use chemicals to kill the algae (green scum) in the pond because these weed killers will kill the plants that are irrigated with the water.

A screen over the barrels is a good way to keep the mosquitoes out, but it must be a fine mesh, and it must be maintained to prevent holes and clogging. Other covers can be used with downspouts and overflow outlets if they are tight enough to keep the insects from entering. Inlets and outlets would require screening.

Insecticides can be used to keep the mosquitoes from living or reproducing in the water. An ounce of almost any insecticide added to 55 gallons of water will kill the larvae. Malathion was one that was effective, and that amount of insecticide had no effect on the plants. No insecticide can be used with goldfish, even a little spray drift into the barrel has killed fish of mine.

Distilled water: Most desalinization projects use distilled water. Chemical processes for removing salt seem to be expensive and difficult. The largest and cheapest source of distilled water that most of us have is the condensation water from the cooling coils of the air conditioner. Systems can be worked out to use the condensation water for lawn watering as well as for house plants, but if provisions were not made at the time the house was built, then it is usually expensive to convert the system so it can be used for watering. Window air conditioners can be used by placing a barrel under the overflow and drain to collect the condensing water. This provides good irrigation water for potted plants.

De-ionized water: A Bryan plant store who also manages plants in and around businesses uses all deionized water. For most people, deionized water is probably impractical or too expensive at this time, but improved methods should be developing.

Surface water: Many of the salts found in well water are not found in surface drainage water, especially near the source. At times this can provide a water source with a lower salt content. However, most permanent streams and rivers exchange water with underground aquifers and have fairly high salt contents. Where the watershed consists of lawns watered with saline water, the streams will have a higher salt content than the original source because of evaporation to the air and dissolving salts from the soil.

Shallower well water: Since the salts in the well water are leached from the rocks it flows through, generally, the deeper the well, the more salt in the water. Sometimes a shallower well, or a well from a different aquifer, can be found with a lower salt content.

Continues on page 61

Susceptibility to Saline Water Irrigation

This is a subjective list of susceptibility to salt in irrigation water. It has been made from observations of plants in my own yard (Bryan water containing 48 ppm chloride & 188 ppm sodium), the TAMU campus (56 ppm chloride, 205 ppm sodium), and in other parts of the state where comparative observations could be made. It includes Wichita Falls water with 137 ppm chloride & 72 ppm sodium, and Wixon WSC water with 140 ppm chloride and 445 ppm sodium.

SUSCEPTIBLE
- American holly
- Sycamore (American)
- Elm (winged, cedar, and American)
- Linden
- Ginko
- Monkey puzzle *(Araucaria imbricata)*
- Rose
- Sweetgum
- Silver maple
- River birch
- Pecan (hickory)
- White ash
- Buttonbush

MODERATE
- Windmill palm
- *Washingtonia filifera* (Calif. fan Palm)
- Hickory (shagbark)
- Norfolk Island pine *(Araucaria excelsa)*
- Pin oak
- Black jack oak
- Bois d' arc (osage orange)
- Slash pine
- Post oak
- Loblolly pine
- Cottonwood
- *Magnolia grandiflora*
- Scotts pine

RESISTANT
- Austrian pine
- Yaupon *(Ilex vomitoria)*
- *Citrus*
- *Pyracantha*
- *Green ash*
- *Ligustrum*
- *Japanese yew (Podocarpus macrophyllus)*
- *Chinese holly*
- *Avocado*
- *Arizona ash*
- *Live oak*
- *Chinese tallow*
- *Pindo palm*
- *Russian olive*
- *Siberian elm*
- *Agave*
- *Yucca*

Order within classes is from most susceptible to most resistant. Relative values are tentative. Most plants in this list are more susceptible than those listed in USDA Handbook 60, 1954. Plants in both lists are resistant in this list and of "low salt tolerance" in the Handbook. Listings agree with those in Dirr(1976).

NITROGEN SOURCES FOR TURF FERTILIZATION

A seminar presented during the 20th Annual Illinois Turfgrass Conference December 18-20, 1979, Champaign, Illinois

NITROGEN SOURCES FOR TURF FERTILIZATION

NITROGEN: THE 'TNT' OF TURF FERTILIZATION PROGRAMS

By John R. Street, Associate Professor, Department of Agronomy, Ohio State University, Columbus, Ohio

Turfgrass growth is dependent on maintaining an adequate supply of all essential plant nutrients as well as properly managing a multiplicity of other cultural and edaphic factors. There are at least sixteen elements considered necessary for plant growth and development. Nitrogen is the essential element that receives the most attention in turfgrass fertilization programs. Nitrogen is the element to which turfgrass is most responsive. The nitrogen content of the turfgrass plant is usually higher than any other essential element (i.e. 3-6 percent on a dry weight basis). Nitrogen is a very dynamic element in the soil system. The concentration of soil nitrogen is in a constant state of change. Nitrogen depletion in soils may result from leaching, clipping removal, volatilization, denitrification, immobilization, or nitrogen fixation in the lattice structure of certain clays. Thus, nitrogen must be added to turfgrass sites on a routine basis in order to maintain a sufficient soil level for turfgrass growth.

Generally, nitrogen additions to the turfgrass system from clipping return, decomposition of organic matter, topdressing, nitrogen fixation, and rainfall are not sufficient to supply the needs of high quality turf. The main source of nitrogen is added by the application of nitrogenous fertilizers. Nitrogen fertilizer is initially added to the turfgrass system as ammonium (NH_4+) and/or nitrate (NO_3-) or some nitrogen carrier that eventually breaks down to ammonium. The turfgrass plant absorbs nitrogen from the soil as either ammonium or nitrate. Nitrate is the predominant form absorbed by the plant since ammonium is rapidly converted to nitrate by soil bacteria. This biological oxidation of ammonium to nitrate is called nitrification. Nitrification is a two-step process in which the ammonium is converted to nitrate (NO_2-) by Nitrosomonas bacteria and then to nitrate by Nitrobacter bacteria. The process is temperature dependent and increases with soil temperatures from 32°F. to an optimum range of 85-95°F.

Once absorbed into the plant, nitrate can be stored in the cell, or reduced back to the ammonium form. The storage of free nitrate within the plant cells results in a luxary consumption of nitrate (absorption of more than is used). This is likely an inefficient use of nitrogen, especially if clippings are removed. Nitrate must be converted to the ammonium form before it can be further utilized by the plant. The reduction process (NO_3- to NH_4+) within the plant requires at least two enzymes (compounds that assist in the reaction). Nitrate reductase is the enzyme involved in the conversion of nitrate to nitrite. Nitrite reductase is the enzyme involved in the conversion of nitrite to ammonium. In grasses, the reduction process predominantly occurs in the shoot or foliar portion of the plant, although some reduction may occur in the roots. The ammonium ion is then readily combined into various complex organic (carbon) compounds within the plant. Chlorophyll, amino acids, proteins, enzymes and vitamins are among some of the organic compounds containing nitrogen. Photosynthesis provides the source of carbohydrates or organic skeletons for the nitrogen assimilation processes.

Carbohydrates produced by photosynthesis are the necessary precursors for the formation of nitrogen-containing amino acids and proteins which are utilized in growth processes. The more turfgrass growth, the greater is the demand for carbohydrate. Carbohydrate is also the key source of energy for maintaining all the various growth and physiological processes within the plant. Carbodydrates are broken down into carbon dioxide and water through a process called respiration, and energy is released. Respiration therefore is a "carbohydrate-utilizing" process. When the rate of photosynthesis exceeds the rate of respiration and the requirement for growth, carbohydrates accumulate as reserves. Carbohydrate reserves are usually stored in the crowns, rhizomes and stolons of cool-season grasses. Carbohydrate reserves are desirable since they serve as an immediate source of energy and carbon skeletons for regrowth and recovery from defoliation or stresses that may injure or thin the turf. A "carbohydrate deficit" may develop when respiration rates are high and/or growth is rapid. Usually any factor that stimulates rapid topgrowth will deplete or drain carbohydrate reserves. The turfgrass manager should manipulate cultural practices so as to maintain an adequate level of carbohydrates within the plant for normal as well as unusual energy and growth demands. In essence, the carbohydrate status of the plant reflects the energy status of the plant.

Nitrogen fertilization has a definite effect on the carbohydrate status of turfgrasses. Nitrogen applications favor turfgrass growth. As nitrogen rates are increased, usually more topgrowth is produced. More topgrowth results in the use of more carbohydrate. Physiologically, under rapid growth conditions shoots take priority over roots and rhizomes for available carbohydrate. Shoot growth will usually continue to respond to higher nitrogen levels causing a distinct suppression in root growth and other growth processes.

These effects are well illustrated from a fertilization study evaluating the response of a Merion Kentucky bluegrass sod to incremental rates of nitrogen (Table 1) (3). Higher nitrogen rates resulted