occurring bacteria to transform all N to nitrate within several days.

Slow-release N

The slower release products are transformed to ammoniacal and nitrate-N in complex pathways. Generally the transformation involves overcoming either a physical barrier between the fertilizer and the environment or a requirement for a number of chemical and microbial transformations.

The traditional concerns of fertilizer selection should be expanded to include leaching potential. The information contained in Table 1 provides additional factors to consider when choosing one fertilizer form over another.

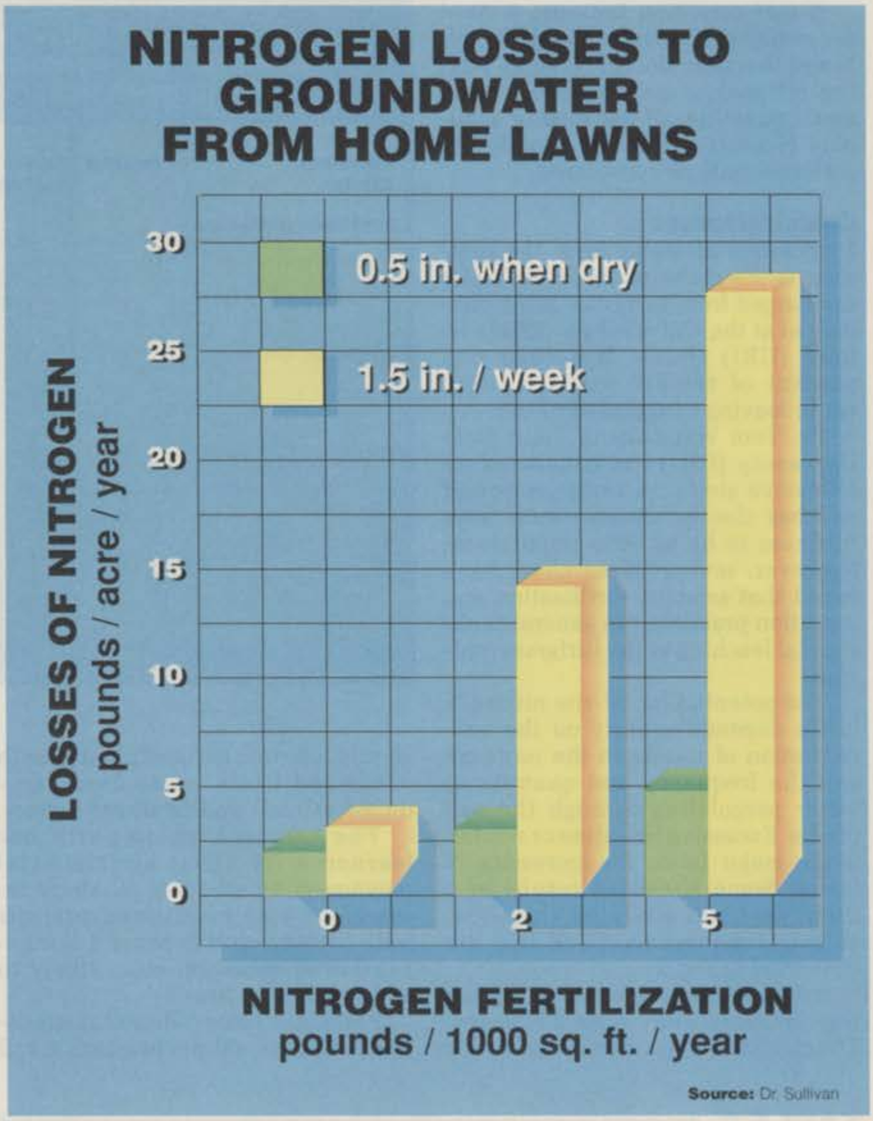
The leaching potential of a product is a result of the residual strength of the fertilizer N material and its nitrate evolution in relation to plant demand. Ammoniacal N can be absorbed by plants and microbes. It usually is not found in very great quantities because of almost immediate transformation to nitrate.

Mobile in soil

Regardless of the formulation applied, nitrate N that is not taken up by either growing plants or soil microorganisms moves readily with soil water. It is a mobile anion which moves rapidly from the root zone to groundwater.

The ideal match of turfgrass and fertilizer occurs when the fertilizer results in nitrate N production identical to plant demand. Nitrogen loss is minimized by having adequate N available during growth periods and little N available at rest or dormancy periods.

FIGURE 2.



Water management critical

Careful attention should be paid to soil water status at the time of, and immediately after, pesticide or fertilizer application.

To reduce potential of agrichemical losses, soil water should be maintained at a slight deficit. A small soil water deficit will not inhibit plant growth and will create a storage buffer to accommodate unanticipated heavy rainfall or excessive irrigation practice.

An irrigation program designed to maintain soil moisture at around 85 percent of field capacity would provide a modest storage capacity. In contrast, a turfgrass rootzone maintained at field capacity is a prime candidate to have all nitrate-N and other fully soluble and mobile elements readily flushed from it.

Any regular flushing of a heavily loaded root zone thus leads to lost fertilizer, lost investment and a high potential for environmental contamination.

—Dr. Sullivan□

Earlier this year Roch Gaussoin, Ph.D., in his article, "Early-season Fertilization" (Landscape Management, February, 1990) offered some recommendations on managing both cool- and warm-season turfgrass. His advice to match product, growth period and turfgrass needs was sound.

Dr. Richard Hull at the University of Rhode Island has conducted work that reinforces Dr. Gaussoin's comments. His project documents how different fertilizer materials can result in greatly different losses and that it's essential to consider balancing plant need and product.

Less growth, less N

Turfgrass that is not growing vigorously has reduced N need. The data in Table 2 clearly shows how the failure to match material and demand results in unnecessary nitrogen loss. The losses are expensive and attributable to excess nitrate supply in relation to plant demand.

If turf condition indicates a need for nitrogen, a program should be followed that provides for N needs. During off-peak growth periods, using small quantities of the readily available N sources that are rapidly absorbed should be considered.

Chemical losses

Percolation of water from the rootzone is the major pathway for water discharged from turfgrass. Work conducted at the University of Rhode Island (URI) shows less than one percent of rainfall and irrigation water leaving turfgrass as runoff.

Dr. Tom Watschke of Penn State University (PSU) has conducted an extensive study on turfgrass runoff and has clearly shown runoff from turfgrass to be of little importance. However, several researchers have found that selected fertilization and irrigation practices can generate substantial leaching of the turfgrass rootzone.

The potential for off-site nitrate-N losses depends entirely on the concentration of nitrate in the rootzone and the frequency and quantity of water percolating through the soil profile. Excessive irrigation or rainfall is the major factor for increasing N losses. Some N-related results of a three year URI study on irrigation, chemical management and turf are contained in Fig. 2.

Irrigation management is a great way to dramatically reduce N losses. The careful management of soil water should take into account plant growth needs and likely water needs, predicted rainfall and fertilizer history.

The research community has learned a lot about agrichemcial movement by studying N. Many researchers and monitoring projects have focused on N because it is inexpensive to measure, more likely to move and more heavily

Pesticides have different degradation pathways, affinity to attach to soil or organic matter, movement pathways and absorption characteristics by plants or microbes. A number of studies involving pesticide percolation, particularly with those thought to be highly mobile, have shown little to be concerned with.

Encouraging results

Recent work with 2,4-D and dicamba at PSU and the URI has shown only limited pesticide movement. Even rain or irrigation events which produced runoff or percolate immediately after application moved very small amount of product.

PSU efforts showed that only 1 to 2 percent of 2,4-D and dicamba moved if excessive rain or irrigation occurred shortly after application. Research at URI and a number of other locations identifies only very limited movement in percolate water.

The URI work followed the movement of 2,4-D and dicamba applied at rates up to three times the normal application. Over 90 percent of all water samples leaving plots with the higher pesticide rates contained no pesticide or less than 1 part per billion of contamination. Further work has shown that healthy turfgrass creates an environment ideal for the retention and degradation of these pesticides. **LM**

W. Michael Sullivan is an associate professor of plant sciences at the University of Rhode Island. He is also extension agronomist and director of analytical services for Cooperative Extension.

TABLE 1.

Classification, burn potential, low temperature response and residential effect of common turfgrass nitrogen sources.

Fertilizer choice	N content %	Burn potential	Leaching potential	Low Temp Response	Residual Effect
Synthetic Inorganic					
Ammonium nitrate	34	High	High	Rapid	Short
Calcium nitrate	16	Very High	High	Rapid	Short
Ammonium sulfate	21	Very High	Mod. High	Rapid	Short
Synthetic Organic					
Urea	45	High	Mod. Low	Rapid	Short
Urea solutions	30	High	Mod. Low	Rapid	Short
Sulfer coated urea	35	Low	Low	Moderate	Moderate
Isobutylidene diurea	30	Low	Mod. Low	Moderate	Moderate
Methylene ureas	42	Low	Low	Low	M-Long
Ureaformaldehyde	30	Low	Low	Low	Long
Natural Organic					
Activated sewage sludge	6	Very Low	Very Low	Very Low	Long

Source: Dr. Sullivan

TABLE 2.

Total nitrogen loss due to leaching during the winter-spring season following a late fall application

GRASS	FERTILIZER*	NITROGEN LEACHED lbs/ 1000 FT^2	% lost
Kentucky bluegrass	NH_4NO_3	2.7	54.1
	Urea	0.7	13.6
	UF	o.2	3.8
Chewings fescue	NH_4NO_3	2.3	45.4
	Urea	1.7	33.1
	UF	<0.1	0.8
Perenial ryegrass	NH_4NO_3	2.0	40.0
	Urea	1.0	20.7
	UF	0.1	2.3

*N Applied at 5lbs/ 1000 FT on 16 November 1988. Hull 1989

Source: Dr. Sullivan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Superintendent Brian Heywood opens his gear drive and impact rotors before using a 185 or 205 cfm air compressor to blow out all the water.

IRRIGATION EQUIPMENT: AVOIDING WINTER DAMAGE

Three superintendents suggest a few basic steps to prevent winter damage to irrigation equipment.

by David Ferron, Rain Bird Golf Division

Your irrigation system represents a substantial investment of money to maintain quality turfgrass, so don't let winter's extreme temperatures damage its pipes.

Winter weather can be unpredictable. In many parts of the country, temperatures will sink low enough to warrant draining or blowing out all the water in the pipe network to prevent cracking. In the coldest areas, the ground may freeze from three to four feet deep. Superintendents must take the maximum precautions for their area.

Snow cover during much of the winter season will help keep the ground from freezing very deep, but most superintendents still blow out the pipe network since it takes less time and expense than repairs the following spring.

Golf courses in transition zones must keep water in their pipes to maintain soil moisture during some of the dry winter months. Superintendents there are taking a chance and can expect some damage in the coldest winters.

Jim Perrin, superintendent of Cameron Park (Calif.) Country Club, does not blow his irrigation system out and may have damage if the winter temperatures dip too low, like in 1988 when he lost two brass gate valves on his back flow preventer.

If you are new to the area, ask nearby superintendents what precautions they take. Experience is the best source of information.

Two methods are used to remove water from the irrigation system: via drains installed in the pipe network or by blowing out the water with an air compressor.

Draining downhill works

Draining will work on some small irrigation systems if the pipe is set with a slight downhill grade. Draining may leave pockets of water on large systems, which could cause problems. Blowing the water out of the pipe with a large air compressor is the most thorough method used today.

Bo Cichuniec, superintendent of The Country Club at Castle Pines, Castle Rock, Colo., says winter damage is only a problem when the winterization process is not done correctly.

Cichuniec may need to water the greens and tees in winter since the ground does not maintain any snow cover. When the irrigation system was designed, a secondary main line was added two to three feet deeper than the primary main line, allowing it to remain charged throughout the year.

Quick-couplers are attached along the fairways and around each green and tee. A stop-and-waste valve is opened manually to charge the quick-coupler and turned off after each use. The stop-and-waste has a drain hole to allow the water to escape from the four-foot nipple.

Cichuniec says his primary problem is when a gate valve leaks water back into the shallower system. Golf course personnel must be sure to close all the gate valves tightly to prevent any damage.

Cichuniec uses a 750 cubic feet per minute (cfm) air compressor to blow out the irrigation pipe network. He says that it can take up to two days to complete the job. He attaches the air compressor to a quick-coupler at the pump station and pushes the water out from there.

Cichuniec is lucky that most of his golf course lies on the side of a mountain and the slope is downhill from the pump station. The main line connection to the pump is to a 14-inch pipe that holds a very large volume of water. His sprinklers are valve-in-head models and he's able to use the controller to turn on each rotor, keeping it on until air begins to come out the nozzle.

Reduce air friction

It's important not to allow the air to leave the rotor for a long period since air causes friction and heat can build up easily. Cichuniec says he has heard of pipe melting from air moving through at high velocity, but he hasn't had any such trouble.

Brian Heywood, superintendent at Jackson Hole Golf and Tennis Club, Jackson, Wyo., begins winterizing his system by draining the pipe in the lower areas. He then rents a 185 or 205 cfm compressor to blow out the rest of the water, starting from the higher end of the course and working downhill through the valves. He adds it may take five days to do a thorough job.

During most of the winter season the course has a good three feet of snow cover, which helps keep the lines open and safe from damage, even though air temperatures are well below zero during the coldest months of the season.

Activate all rotors

The crew at Jackson Hole turns on every rotor. Heywood has both gear drive and impact rotors on his course. He notes that gear drive rotors require more air to get them to turn on and suggests turning them on manually to insure water removal.

John Alexander, superintendent at Bend (Ore.) Country Club, waits as long as he can before blowing his system out to prevent the soil from drying out. He starts from the highest points on the course and uses the clock to turn on the sprinklers.

Alexander emphasizes that it is important not to let the air leave the sprinkler for too long a time. In the past he has melted a two-inch brass valve. He also prefers a smaller compressor since a 650 to 750 cfm model melted some four-inch pipe and blew sprinklers out of the ground.

Compressors vary in size from small 10 to 15 cfm to the very large 750 cfm size. The size you choose will depend on the amount of water you are trying to remove. The volume of water will depend on the pipe size that makes up the hydraulic network of your irrigation system.

What compressor size?

Alexander prefers using a smaller compressor and going through the system a couple times to be sure all the water is removed.

Cichuniec says that it takes two full days to get all the water out of his 14-inch mainline leaving the pump house. While the air easily pushes the water out of the top half section of pipe, it takes a little extra effort to get the rest out.

Though there are no specific rules of thumb when it comes to choosing an air compressor, the best way is to start small and work your way up.

The most important element to remember when removing water from your irrigation system is to begin releasing the water at the highest point on the golf course and work down from there. Use the controller to electrically turn on the sprinklers or turn each on manually, and be sure not to let the air leave the rotor for a very long time. **LM**

Wyoming's three feet of snow cover is probably enough to protect irrigation lines from freezing and cracking, but Heywood takes no chances.

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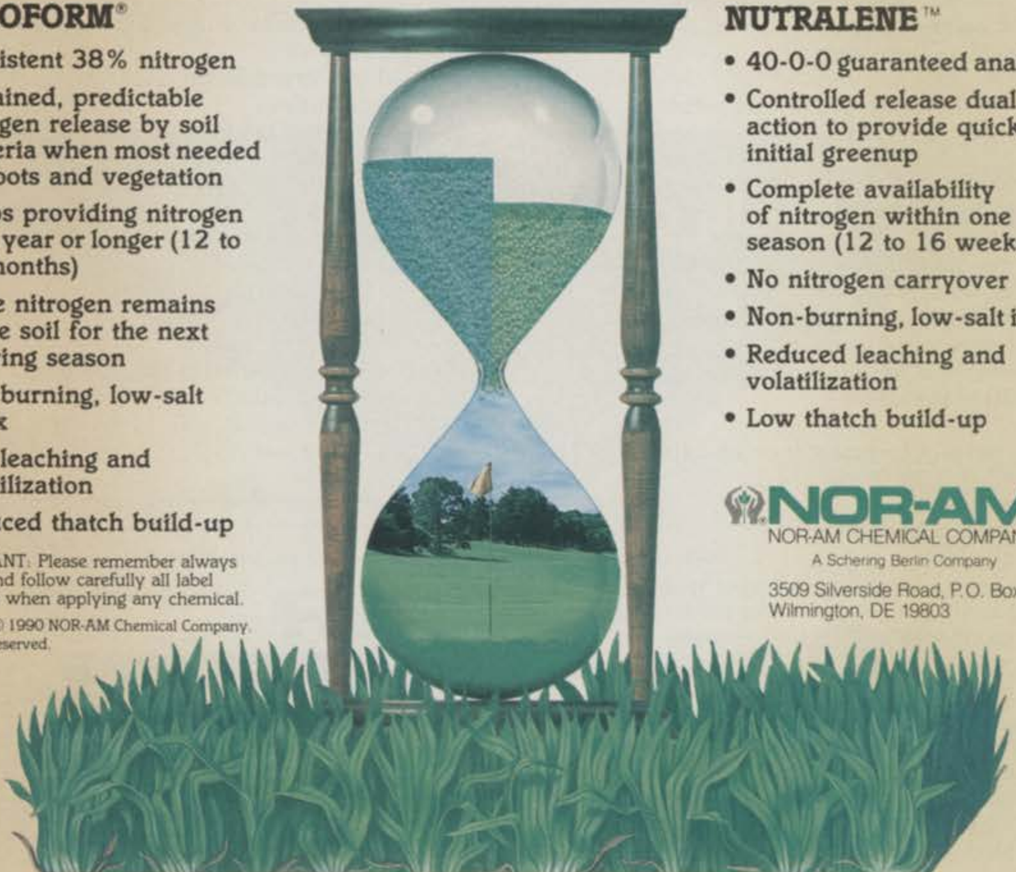

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QUICKIE-QUIZ

Soils and their effects on turf growth

Soil Texture Classification

Soil separate	*Diameter* mm	*Particles/gm* number	*Surface area in 1g.* sq. cm
stone	over 25	—	—
coarse gravel	25-5	1	—
fine gravel	5-2	30	—
very coarse sand	2-1	90	11
coarse sand	10-.5	720	23
medium sand	.5-.25	5,700	45
fine sand	.25-.1	46,000	91
very fine sand	.10-.05	722,000	227
silt	.05-.002	5,776,000	454
clay	below .002	90,260,853,000	8,000,000

1. The number of natural soil types identified in United States is more than:
a) 70
b) 700
c) 7,000
d) 70,000

2. Peat is a preferred soil additive because:
a) it improves nutrient retention
b) it deteriorates slowly
c) both of the above

3. The ideal soil pH for growing plants is:
a) neutral
b) slightly acidic
c) slightly alkaline
d) strongly alkaline

4. Besides neutralizing soil acidity, lime applications:
a) add calcium and magnesium
b) increase compaction
c) decrease soil salinity
d) all of the above

5. Soil compaction under turf can extend as deep as:
a) one inch
b) four inches
c) one foot

6. Most fertilizers tend to make soils:
a) more acid
b) more alkaline
c) neither

7. Generally, saline soils develop because of:
a) adapted plant species
b) poor drainage
c) excessive traffic
d) all of the above

8. Most sands are composed primarily of:
a) mica
b) feldspar
c) quartz

9. Low oxygen supply through the soil to the plant can be caused by:
a) compaction
b) overwatering
c) both

10. The dark color of topsoil is caused by the presence of:
a) earthworm casings
b) potassium
c) mineral matter
d) moisture

11. In areas where earthworms are prevalent, rainfall penetrates the soil:
a) more rapidly
b) less rapidly
c) neither

12. Thatch accumulation is favored in:
a) clayey soil
b) sandy soil
c) loamy soil

Source:

Turf Managers' Handbook
COMPREHENSIVE PRACTICAL INSTRUCTION FOR ALL TURF PROFESSIONALS

ANSWERS:

1.c; 2.c; 3.b; 4.a; 5.b; 6.a; 7.b; 8.c; 9.c; 10.c; 11.a; 12.a

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Sub-irrigation system suits 49ers' turf pro

Hey, call it coincidence. But Rich Genoff, sports turf manager of the San Francisco 49ers, points out the facts: "I came here in '88," he says with a broad grin, "and the 49ers have won the Super Bowl ever since."

Genoff will concede that just maybe the 49ers could have pulled it off without him, but there's no more of a 49er at heart than he.

In fact, Genoff spends more time on the practice fields at the team's new Marie P. DeBartolo Training Camp in Santa Clara, Calif., than do the players. As the only full-time groundskeeper, he can be found there year-round, at practically any hour of the day or night.

"It's my baby," he says of the 4.5 acres of grass. "I do everything but tuck it in and kiss it goodnight. And it doesn't bother me to put in a 16-hour day if that's what it takes to keep this turf top-notch all the time. The condition of the practice facility is real important to me and to the team. The better it looks, the better they feel."

Diseases are warded off the champion 49ers' practice fields by Rich Genoff.

The Warren's A34 bluegrass turf sits on 16 inches of sub-irrigated sand over a plastic barrier. The field also has fully automated overhead irrigation, using 690 sprinkler heads and a PSI pumping station.

"I use the overhead irrigation for seeding, to water in chemicals, or to prime the field when it gets dry," Genoff explains, "then I sub-irrigate for about an hour-and-a-half, and that lasts me up to two weeks.

"The sub-irrigation is great. I can control it from a panel in my office, and don't have to worry about clocks going off or heads sticking open. I could water the field while the team is playing and they'd never know it."

The system also conserves water, he explains, because he's not losing anything to evaporation. With water in short supply throughout California, that's an important benefit.

Coming from a golf course background, Genoff is used to replacing divots. "But I've never seen divots like we take out here," he laughs. "These are big guys and they are fast. When you get 110 of them here for a mini-camp, all trying to impress the coaches, they really get into it. And when they stop and make a cut, the turf goes flying. But I would rather they take a divot than have that grass lock up and injure a knee. It means the turf is doing exactly what it's supposed to do."

Genoff acknowledges that turf diseases are a problem, just as they are a problem on most high-maintenance turf.

"*Poa annua* is my worst enemy, like it is with any turf man who wants a nice stand of bluegrass," Genoff states. But he gets excellent results with Chipco Ronstar G brand herbicide as a pre-emergent. He applies the material in late March and again in September. "It does a real good job keeping the lawns weed-free and that helps me devote more time to the playing fields."

When the practice field was first laid down, Genoff used Chipco Ronstar on it twice for year-long pre-emergence control. "It performed very well," he reports, "but because of the heavy use of the practice turf and the need to frequently re-seed, it's hard to schedule in a pre-emergence application. I've had to go to spot sprays on the playing turf. It's a constant battle, but I haven't found anything that