a better appearance on the thick bermudagrass. After two weeks of 20-hour work days, Kuykendahl had the field ready for its debut. "It was tough at first, especially when I realized how much Joe Robbie had put into the success of the stadium," says Kuykendahl. "I kept in constant touch with Dr. Daniel, Laurel Meade, Harry Gill, Steve Wightman, Turner Gibson and Bill Wilson. They helped me through the initial problems so I could concentrate on the PAT system."

The primary aspect of the PAT system Kuykendahl had to learn was the portion that senses and controls the amount of moisture in the root zone. Ten pairs of moisture sensing probes are imbedded in the sand field. Each pair of probes is located approximately 20 feet away from the second sprinkler of each irrigation zone. The two probes are placed 20 inches apart from each other. Probes are placed in the top two inches of the root zone and four inches below the surface. Using feedback from the probes Kuykendahl knows the surface and subsurface moisture levels in various locations around the field.

If the probes indicate the desired level of moisture has been reached it will halt further irrigation. A time clock also restricts surface irrigation to early morning. When Kuykendahl fertilizes he has to override the moisture control system to water the nutrients into the soil. "It sounds complicated, but it works great once you understand it," he says.

After calcined clay was mixed into the top three inches of sand, the field was irrigated to bring moisture levels up to specifications.

Daniel provided Kuykendahl with a year-round schedule for the PAT system. During the winter (November through April) all gravity drains are open and moisture is applied as needed by the surface irrigation system. During the summer, however, the gravity drains are closed and both surface and subsurface irrigation are used. The drains are opened only in case of excessive rainfall.

In the case of heavy rain, the gravity drains are closed and the valves to the two pumps are opened. To override the moisture control system the control is set higher than

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NFL PLAYERS WRITE TURF INTO CONTRACT

In the future, all open-dome stadiums will be natural turf if the National Football League Players Association (NFLPA) reaches agreement with the NFL owners during negotiations for a new three-year contract. NFLPA has asked for conversion of all outdoor stadiums with artificial turf to natural turf and a ban on artificial turf at future open-air stadiums. The group made a similar request for its previous contract but dropped the issue during a last minute compromise.

John Macik, sports medicine coordinator for the NFLPA, has conducted surveys on field-related injuries at NFL stadiums in preparation for the negotiations. His results indicate that artificial surfaces were responsible for twice as many career-threatening injuries as natural turf. Macik has also reported players greatly prefer natural turf.

NFLPA has also asked for a joint-sponsored safety study of many different areas of professional football. The study would evaluate safety of fields, equipment and programs during mini-camps and training camps. "The players are seriously concerned about anything that can permanently harm them and shorten their careers," states Macik. "We have the data to prove to the owners that natural is safer. In many cases, the owners (of the teams) do not own their home stadium. NFLPA believes the owners, as important stadium tenants, have sufficient influence to have fields converted to natural turf."

At presstime, the negotiators have failed to reach agreement. The players went on strike September 21. The owners cancelled all scheduled games for one week and have said they will field teams the following week consisting of players willing to cross the picket lines and those who were cut before the season started. "The only thing we have reached agreement on so far is the length of the contract," said Dee Rauch, NFLPA's public affairs officer.

GROUND BROKEN FOR SPORTS TURF CENTER

The first two acres of turf research plots have been installed by University of Missouri staff at Powell Gardens in Lone Jack, MO, to begin development of a National Sports Turf Research Center. The University is working in cooperation with the $80 million Powell Foundation and DuraTurf Enterprises Inc. of Leawood, KS, to develop a facility on a 240 acre site east of Kansas City to serve as a center for U.S. sports turf research.

Dr. David Minner from the university's department of horticulture in Columbia, planned and supervised construction of the first plots in August. A two-acre site was graded and irrigation was installed before a variety of sports turf root zones were seeded. Minner plans to place the various root zones and types of turfgrass under an assortment of maintenance and wear tests. Minner and his staff operate out of two construction trailers, one containing a small soils laboratory.

Construction of the first permanent building should begin this spring, according to David Doherty, president of DuraTurf. His company will pay for the 14,000 square foot building to contain a state-of-the-art soil testing laboratory, classrooms, offices, a small dormitory, and equipment storage. The company will make the facilities available to the university for research and teaching. A computer data bank of sports turf specifications and research results will also be available both nationally and internationally.

Doherty hopes to provide a 48-hour turnaround soil testing service as soon as the lab is completed. "Who can wait two to three weeks for results of a soil test?" asks Doherty. "Sports turf managers should test their soil frequently and that means they need results quickly."

Minner has completed the first grant proposal for the Center asking for $460,000 over a three-year period from the state's Research Assistance Act. The funds would be used to conduct research at the Lone Jack facility. He plans to apply for a federal grant as well.

"The idea is to select the best performing combinations of root zone and turfgrass from the research plots and use them to construct between two and five football/soccer fields as soon as possible," explains Doherty. "We want our young athletes to play all out on these state-of-the-art fields to show us which is the safest and most durable. Comprehensive data will be kept on each field and made available to the public. Then, for once, we won't have to keep repeating the same mistakes at the expense of our kids' knees, ankles and shoulders."

CHICAGO TO INSTALL NATURAL TURF AT SOLDIER FIELD

The Chicago Park District has agreed to replace the eight-year-old Astroturf in Soldier Field with natural turf after repeated requests by the Chicago Bears. Natural turf was considered when the current field was installed in 1979 but lost a price struggle to the artificial surface. Two years ago the Bears asked again for natural turf when it became apparent the resiliency of the pad under the field was failing. General Manager Michael McCaskey has consistently stated that he wants the Bears, "To play on real green grass under the blue sky."

Astroturf Industries has been testing the resiliency of the field every summer. Ken Mrock, supervisor of maintenance for the stadium and six golf courses for the Chicago Park District, explains that gas bubbles originally contained in the pad have ruptured making the field harder. Mrock keeps the field covered most of the time to prevent moisture from getting into the pad and freezing during cold weather. He also blows heated air from Kerosene heaters under the tarp to soften the pad for winter games.

Bears management, especially coach Mike Ditka, have not concealed their intention to build another stadium in the Chicago area. Difficulty finding the right location has delayed the move and the team's lease at Soldier Field extends into the 1990s. Once a site and financing are obtained, it would take three or more years to build. Joe Robbie's success in Miami building a privately-financed stadium has encouraged Bears management.

"The stadium has been renovated and is in good shape except for the field," explains Mrock. It currently seats 66,000 fans and has 65 skyboxes. "There's not a bad seat in the house. It's tough to find a location as good as Soldier Field." The stadium is situated on Lake Michigan near the Loop and McCormick Place.

"I'd like to see natural turf," says Mrock. "It's not my decision to make, but that's my opinion. You can tell the players and coaches like it better. That should be worth something when you compare the cost of one against the other."

BOARDWALK AND BASEBALL PREPARES FOR THE ROYALS

Kansas City Royals General Manager John Schuerholz (left) and Boardwalk & Baseball President Dick Howard examine a model of the 6,500-seat stadium to host the Royals for spring training in 1988. The facility is 25 minutes from Orlando, Florida.

Lawn Maintenance

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se the heavy duty wheeled blower to move large quantities of leaves ward the truck.

The intake hose vacuums leaves piled up around the truck and sends them through the four-bladed steel impeller in the truck loader. By crushing leaves and debris into small particles, the impeller greatly reduces bulk. This allows the truck to hold more debris and prevents operators from having to unload the truck as often.

Sports Turf Nutrition
A Special Diet For High

Ground-driven rotary spreader.

Statisticians keep records on some strange yet important facts. For example, people spend more than a third of their life sleeping, more than a fourth of it working or commuting to work, and nearly a tenth of it eating. With all that time invested we should concentrate on making the most of it.

If these same statisticians evaluated the daily routine of sports turf managers, they would no doubt find a large portion of their day is spent on the basics of mowing, fertilization and irrigation. There are other, more exciting aspects of the job that draw their attention away from the basics, but the best sports turf managers remain vigilant to their skill in the basics.

To the novice, fertilization seems simple, yet it is the most complicated of the basic management practices for sports turf. Fertilization provides the diet of the turfgrass plant. A poor diet results in weak turf incapable of recovery from the wear inflicted upon it by sports. A rich diet results in lush turf that is vulnerable to diseases and insects, requires more mowing than necessary, and favors foliage growth at the expense of important root growth.

PTO-powered pendulum spreader.

The sports turf manager must determine the amounts of important nutrients needed by high-use turf and the rates at which they need to be replenished. These amounts will typically be different than amounts considered adequate for utility or lawn turf. Turf under stress utilizes nutrients differently than turf in a standard lawn situation. Without a special diet, sports turf is unable to recuperate and will deteriorate with repeated field use.

The amount of nutrients required by sports turf is greatly influenced by the condition of the soil. As mentioned in the article in the September issue by Eliot Roberts and Fred Grau titled *The Living Soil*, clay and humus particles in the soil serve as storage and exchange sites for nutrients. The amount of clay and humus in the soil will affect the amount of fertilizer that needs to be applied during the growing season. Greens, tees and some athletic fields are constructed largely of sand to improve drainage and prevent compaction. These areas typically require more frequent applications of nutrients than clay/loam soils.

The acidity or alkalinity of the soil can also impact fertilizer rates. The measurement used to describe soil acidity/alkalinity is pH. Even though sufficient levels of nutrients may be present in the soil, they may not be fully available to the turfgrass roots when the pH is below 5.5 or above 7. Sports turf soils should be amended to be within this range so the full benefit of fertilizer is obtained. It should also be noted that acidity or alkalinity can hamper the decomposition of thatch and organic matter in the soil.

To lower the pH in alkaline soils or sites irrigated with alkaline water, apply sulfur in the fall or spring after aeration. Fertilizers containing sulfur can also be used in a maintenance program to slowly reduce the pH of alkaline soils. Some of these are ammonium sulfate, sulfur-coated urea, potassium sulfate, sulfate of potash and ferrous sulfate.

The pH of acid soils can be raised by applying lime or dolomitic limestone to the turf in the spring or fall after aeration. Fertilizers containing sulfur should be avoided on turf with acid soil conditions. Correcting soil pH problems may take a series of applications of soil conditioners.

Soil testing is the first step to achieving

Traffic Areas

a balanced turf diet. Every sports turf manager should have a soil probe in his vehicle to pull plugs for soil testing. Pull three or four plugs from each critical turf site and mix them together in an envelope. The soils lab can provide envelopes for this purpose. A two week wait from the time you send the samples to the lab until you receive the results is typical so send in the samples a few weeks before you intend to fertilize.

A $40 investment in soil testing can save hundreds of dollars in fertilizer or pesticides during the year. The test results should provide soil pH, soil type, organic matter content, and levels of all major and minor nutrients. An additional test that provides the sports turf manager with valuable information is a percolation test. This test rates the soil on how well water drains through it. Most soils labs provide recommendations for correcting soil and nutrient deficiencies. By repeating these tests periodically and recording all fertilizer applications as they are made, you will have a good handle on turf nutrition.

These tests help you select the right amounts and combinations of nitrogen (N), phosphorus (P) and potassium (K) and other nutrients for your fertilizer program. However, it is up to the sports turf manager to select from a wide variety of sources for each of these nutrients. He can purchase each of the primary nutrients separately or buy "complete" fertilizers that have been premixed or formulated to contain nitrogen, phosphorus and potassium. Dry, premixed fertilizers are less expensive than formulated products. The dry components are carefully mixed together by the manufacturer, but the individual components may not remain perfectly mixed when applied with rotary spreaders. The heavier particles in these fertilizers can be thrown farther than the lighter particles by the spreading mechanism.

Manufacturers also formulate fertilizers to combine all the nutrients onto particles of a "carrier," such as ground corn cobs, clay or perlite. This eliminates inconsistencies when the products are applied and provides the same proportion of nutrients evenly to the turf. Both mixed and formulated dry fertilizers should be watered into the soil soon after application.

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Gravity feed drop spreader.

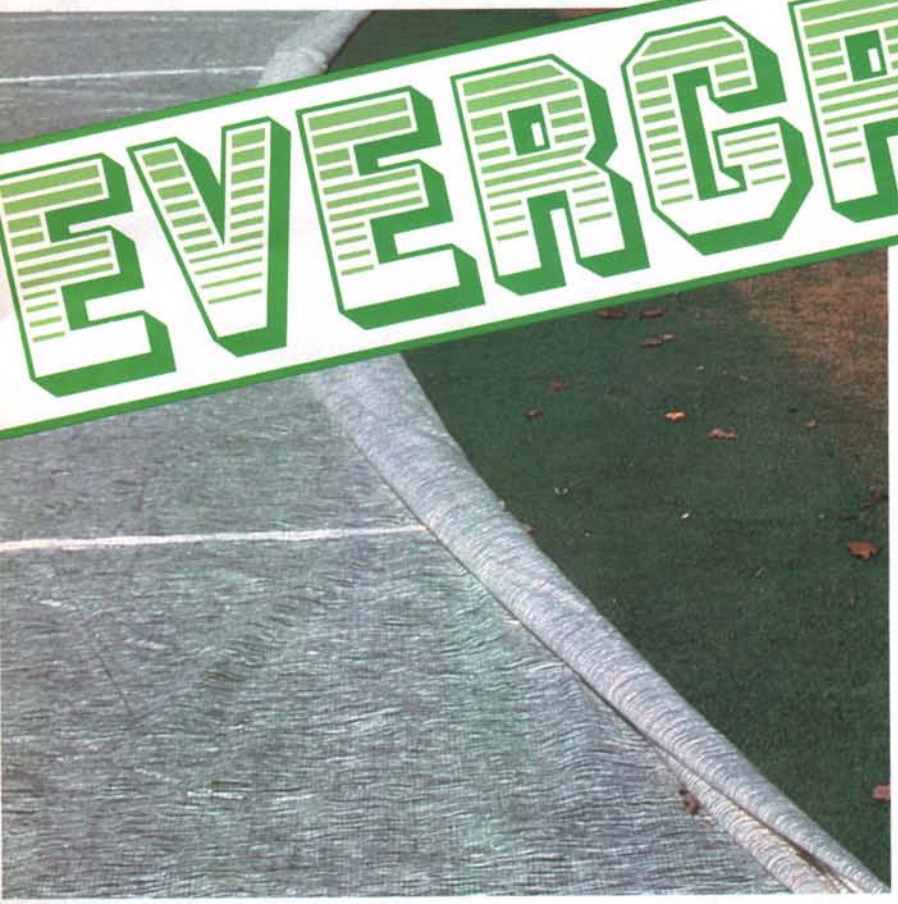
Ground-driven boom sprayer.

Engine-powered boom sprayer on truckster.

HPI™

Hinspergers Poly Industries Ltd.'s

EVERGREEN



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EVERGREEN is designed with the superintendents and turf managers convenience in mind. The covers are lightweight and strong, for easy handling. The one-piece construction and simple anchoring peg system allow installation or removal in less than half an hour per cover. These simple steps are all that's needed to provide trouble-free protection and enhanced germination throughout the year.

Unique one-piece construction is easy to install.

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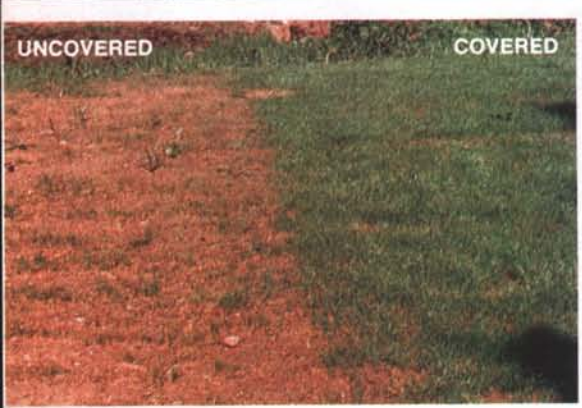
Healthy root development is already underway very early in spring.



ENHANCED GERMINATION. ***EVERGREEN*** *covers create a greenhouse effect stimulating more rapid growth than uncovered grasses.*

Acting as a soil blanket, ***EVERGREEN*** covers retain necessary heat for plant growth while the patented weave construction allows the cover to "breathe", minimizing the risk associated with excessively high temperatures.

Minimizes water requirements by retaining soil moisture near newly planted sprigs and seed at the soil surface.

1) ***EVERGREEN*** is removed from its handy storage bag.

2) The cover is unrolled onto the green or tee.

3) The cover is unfolded onto green or tee.

4) ***EVERGREEN*** is secured with anchoring pegs supplied with each cover.

APPLICATION PROVEN BY GOLF COURSE SUPERINTENDENTS AND TURF MANAGERS THROUGHOUT NORTH AMERICA AND EUROPE

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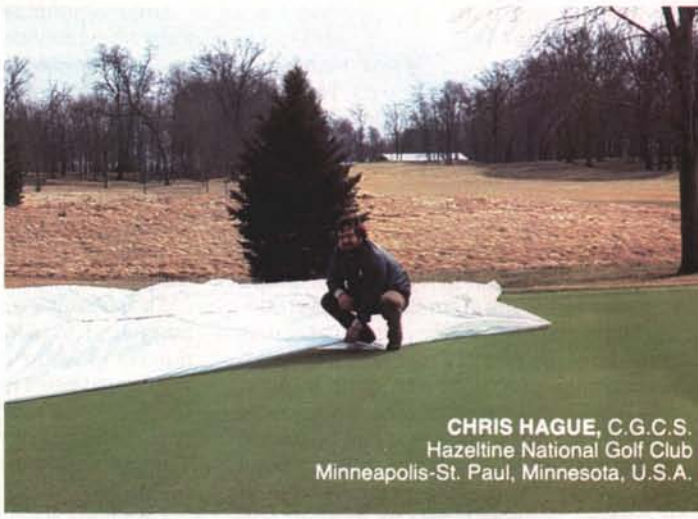
Knollwood Club
Lake Forest, Illinois, U.S.A.

After aerating, reseeding and topdressing various areas on the golf course this past fall, we installed our Evergreen covers. The results were excellent! Good growth continued even during cold, dormant growing conditions. These areas went from 60% coverage to nearly 100% in early spring. Healthy root development was well underway. The Evergreen covering system extended our growing season at least one month in the fall and spring while providing winter protection.



CHRIS HAGUE, C.G.C.S.
Hazeltine National Golf Club
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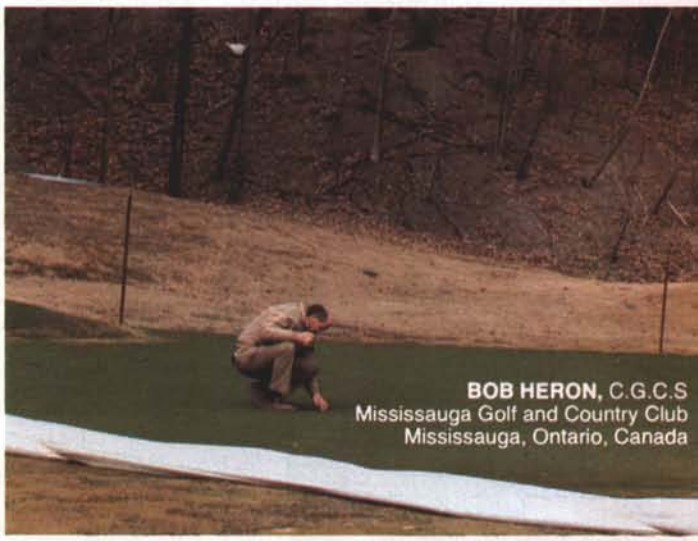
"Over the past few years we have tested a variety of materials designed t protect our greens throughout the winter. In late fall we installed 18 Evergreen one-piece covers. Installation and removal was easy and took less than one day. Our covers can now be re-used for years to come. Thi unique Evergreen covering system is exactly what I was looking for and I recommend them as a positive management technique."



BOB HERON, C.G.C.S
Mississauga Golf and Country Club
Mississauga, Ontario, Canada

"Evergreen one-piece covering systems not only protected our greens from desiccation throughout the past two harsh winters, they also created a greenhouse effect stimulating more rapid growth and enhanced healthy root development in early spring compared to uncovered grasses."

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Sports Turf Nutrition

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Application uniformity is also high when fertilizers are applied as liquids. Nutrients that are in liquid form, soluble in water or that can be suspended in water are available. As long as these materials are compatible with others in the same tank, they provide very even distribution to the turf area.

In all cases, spreaders and sprayers should be checked and recalibrated before applying fertilizers to make sure distribution of the granules or sprays is equal across the width of the swath. One method of avoiding potential problems with gaps or overlaps is to apply a half rate of the material in two directions. A colorant can be added to liquid fertilizers for visible proof of skips and overlapping. Use the same spreader or sprayer to apply fertilizers to an important turf area to avoid inconsistencies caused by differences in the equipment.

Fertilizers, whether they are mixed or formulated, complete or incomplete, liquid or dry may contain a wide variety of nutrient sources. The sports turf manager needs to know how these different nutrient sources will affect his turf.

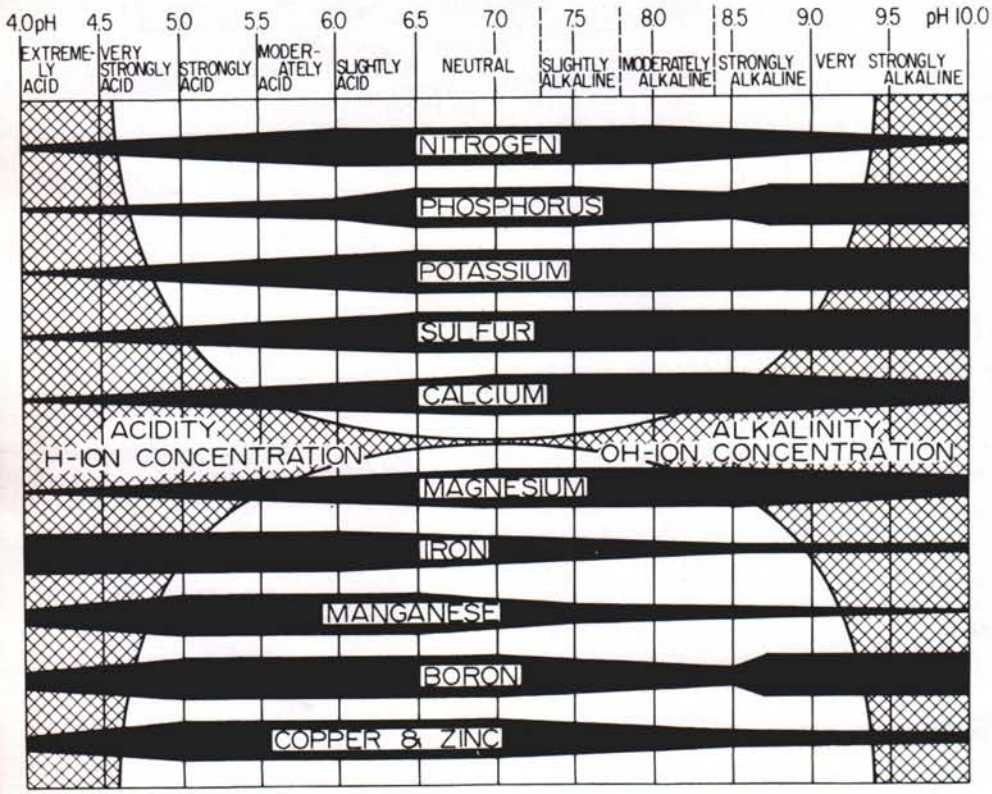
The most important component is nitrogen. Each nitrogen source has its own burn potential and rate at which it releases nitrogen. Commercially produced organic fertilizers, such as CompGro and Milorganite, contain a low percentage of nitrogen and release it slowly as they break down. Their burn potential is extremely low. However, it takes larger amounts of these products to provide the same amount of nitrogen as other sources.

Urea, ammonium sulfate, ammonium nitrate and potassium nitrate are synthetic (man-made) sources of nitrogen. They are also the most economical sources of nitrogen for turf. However, these synthetics contain much greater percentages of nitrogen than organic sources, release it much faster and have higher burn potentials. The sports turf manager should check his application equipment and rates carefully when using these products.

These quick-release fertilizers can be compared to sugar. Sugar breaks down quickly in water and provides the person who consumes it with a short burst of energy. Quick-release fertilizers give turf a fast burst of growth and color and last just a few days. They provide no long term benefit to the plant.

Chemists developed two basic ways to slow down the release rate of synthetic nitrogen fertilizers. The first was to chemically bond nitrogen to other elements through a reaction process. Ureaformaldehyde (Nitroform) and isobutylidene diurea (IBDU, Par-Ex) are synthetic fertilizers that release nitrogen over many weeks. Even though they contain a relatively high percentage of nitrogen, their slow release rate gives them a very low burn potential.

Ureaform is really a group of compounds created simultaneously by reacting urea with formaldehyde under controlled conditions. These products release nitrogen as microbes in the soil break them down. Changes in microorganism activity will alter the rate of release. Low soil temperature reduces microbial activity and slows the release of nitrogen.



The availability of fertilizer nutrients in the soil can be changed by soil pH. Chart courtesy: American Society of Agronomy.

By changing the conditions under which urea and formaldehyde are reacted, slightly different fertilizers are produced. A number of these are categorized as methylol ureas or methylene ureas. These slow-release fertilizers also contain a certain portion or their nitrogen in the form of urea.

IBDU is created by reacting urea with isobutyraldehyde. Water in the soil slowly decomposes the IBDU releasing the urea contained in it. The two things that influence the rate of breakdown of IBDU are the size of the particle and the amount of moisture in the soil. Small particles break down faster. Nitrogen release will be slowed by dry soils.

Slow-release fertilizer can be applied less frequently while still providing the turf with sufficient nutrients.

The second method of slowing down the nitrogen release rate of synthetic fertilizers is by coating them. The most economical method of coating to date involves sulfur. Through a process that coats urea droplets with widely varying thicknesses of sulfur, fertilizer manufacturers are able to control the amount of nitrogen escaping through cracks and imperfections in the coating. It takes weeks for all the nitrogen to escape from sulfur coated urea. Lesco Inc., Scotts, and CIL have SCU plants.

A more expensive coating process utilizes plastic. The advantage of a plastic coating is a more predictable rate of release through precise pores in the plastic. The coating can also be much thinner and contain a number of different quick-release fertilizers, including urea, ammonium nitrate and ammonium phosphate. The rate of nitrogen release from plastic coated fertilizers increases with temperature. Manufacturers are continuing their research on plastic-coated fertilizers in order to produce a low cost version in the near future. Sierra Chemical's Osmocote is a plastic coated fertilizer. Estech and Scotts also have products under development in this category.

Slow release nitrogen sources have three primary advantages. The most obvious is the extended amount of time they release nitrogen into the soil. By utilizing slow-release fertilizers, the turf manager can apply fertilizers less frequently while still providing the necessary nutritional benefits to the turf. Finally, the slow rate of release greatly reduces the chance of fertilizer burn.

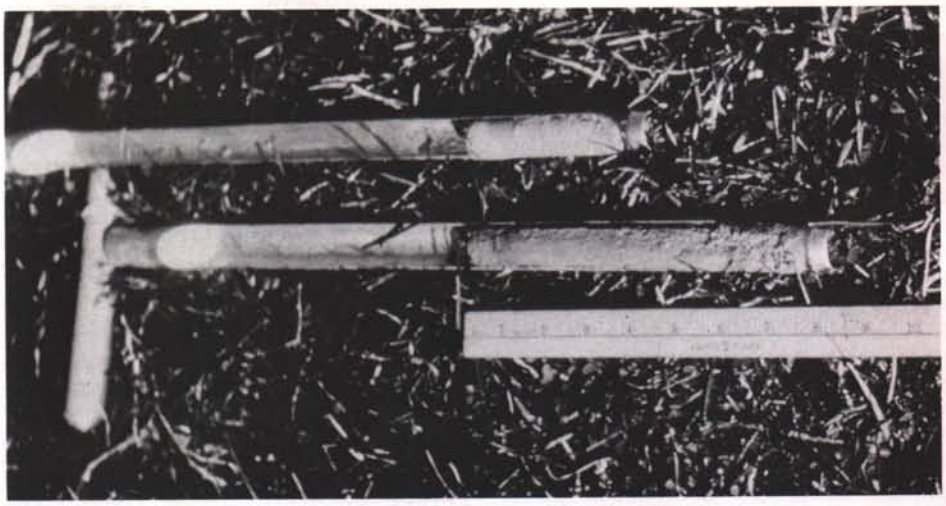
While fertilizers containing slow-release nitrogen cost more for the amount of nitrogen delivered, they reduce the risk of fertilizer burn and provide a nutrient base for

the turf. Many sports turf managers apply fertilizers that contain half or more of the nitrogen in slow-release form. Supplemental applications of quick-release nitrogen can be made to help turf recover from the wear and tear of sports as well as damage from insects and diseases.

While potassium may be listed third in fertilizer analysis ratios, it is second only to nitrogen in importance for established turf. All parts of the turfgrass plant contain potassium. It is vital for nearly all biological reactions taking place within the plant. Without adequate levels of potassium, the health and recuperative potential of sports turf is severely reduced.

Potassium is linked to improving the winter hardiness, drought tolerance and disease resistance of turf. You could call it the vitamin C of the turfgrass plant. It is essential for proper storage of carbohydrates in turfgrass roots and the overall health of the root system. Without a healthy root system sports turf will not provide a reliable, long-lasting surface.

Due to the utilization of this nutrient by the turf and its movement through heavily irrigated, high sand content soils frequently found in sports turf, potassium levels in the soil need to be replenished regularly. In fact, this may be the element you should watch most closely in soil testing. Potassium deficiency is recognizable as stunted growth, discoloration and rolling of leaf tips and yellowing of older leaves. It is not uncommon to apply a half pound of potassium for each pound of nitrogen.



Every sports turf manager should have a core sampler in their vehicle.

The two primary sources of potassium in fertilizer are potassium chloride and potassium sulfate. Some caution is advised when making separate applications of potassium chloride since it has approximately the same burn potential as urea. Potassium sulfate has a lower burn potential and also provides a slight acidifying effect on alkaline soils. Its use on problem acid soils is not advised.

Potassium nitrate is more expensive than the previous two products and also has a burn potential about the same as urea. Monopotassium phosphate has a very low burn potential but is priced higher than all other potassium sources.

Phosphorus is important to young turf and overseeded turf areas. It contributes to proper root development in seedlings as well as the overall growth of the turfgrass plant. It is important to turf like the calcium in milk is important in the diet of newborns and children. Seedlings in a phosphorus deficient soil will have a red cast instead of bright green.

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Sports Turf Nutrition
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Phosphorus does not move through soils as rapidly as nitrogen or potassium. However, much of it is tied up chemically in the soil, especially in soils outside a pH range of 5.5 to 7.5. By correcting soil acidity or alkalinity, existing phosphorus in the soil will become available. Minerals and organic matter in the soil also provide a natural sourse of phosphorus but at a very slow rate. For these reasons, soil tests are designed to measure orthophoshpate, the form of phosphorus most readily available to the plant.

Most phosphorus sources have a relatively low burn potential and can be applied separately with relative safety. Superphosphates are the most commonly applied source of phosphorus for dry applications. The amount of available phosphorus ranges from 20 percent to 50 percent for triple superphosphate. Monoammoinium phosphate and diammonium phosphate are frequently used for liquid fertilization. Monoammonium phosphosphate is recommended for use on alkaline soils. Excessive applications of phosphorus, especially on alkaline soils, should be avoided when possible since they can tie up iron and make this important micronutrient unavailable to the turfgrass plant.

Iron is the micronutrient of chief concern to sports turf managers. Sandy soils, alkaline soils and waterlogged soils frequently lack sufficient levels of iron. Turf has a sickly yellow appearance termed chlorosis when levels of iron are inadequate. Turf specialists recommend application of chelated iron to correct deficiencies. This iron source is less likely to cause injury to turf than salt forms such as iron sulfate and ferrous ammonium sulfate and remains available to turf for a longer period of time. They are, however, more expensive.

Iron deficiencies can sometimes be solved by correcting alkaline soil conditions or by improving drainage.

Iron deficiencies can sometimes be solved by applying sulfur to correct akaline soil conditions or by improving drainage. Excessive applications of iron can turn turf almost black. However, light applications are being used by some sports turf managers to achieve a darker green shade for turf without using additional nitrogen. In severe cases, applications of iron may be needed every few weeks until the problem is corrected.

Sulfur is also deficient in many soils. It is a vital component of many plant reactions as well as an acidifying agent. In addition to elemental sulfur, many fertilizers contain certain amounts of sulfur, including ammonium sulfate, potassium sulfate, superphosphate and sulfur-coated urea.

Ocassionally calcium, copper, magnesium, manganese, and molybdenum are lacking in sandy soils in certain parts of the country. Calcium and magnesium deficiencies can be corrected with dolomitic limestone. Many complete fertilizers contain small quantities of these micronutrients. Foliar-applied sources are also available for rapid correction of micronutrient deficiencies.

Due to the extensive use of sports turf, it has a higher nutrition requirement than utility or lawn turf. Bentgrass and bermudagrass used for sports require the most nitrogen during the growing season. Bentgrass fairways need almost a pound of actual nitrogen per 1,000 square feet per month during the growing season while greens often receive more. Bermudagrass greens also receive a pound or more of nitrogen per month. Hybrid bermudagrass fairways or sports fields need between 1/2 and 3/4 pound of nitrogen per month. Common bermudagrass on fairways and fields requires half as much as nitrogen as hybrid bermudagrass. Nitrogen rates may need to be adjusted upward for sand-based root

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