of Methyl bromide per 100 sq. ft. of soil. Exposure should be for 24 to 48 hours. Aereation for methyl bromide is 48 to 72 hours; after that time it is usually safe to complete grading and plant. Most fumigation of golf greens is done in this manner.

Manual Tarping Method

(2) Chisel injection manual tarping method: Due to the volatile nature of these fumigants, chisel injection can create some unique problems. Rapid expansion to the gaseous state causes icing of injection tools. This is overcome by dilutions and mixtures with other chemicals which slow down the diffusion of the gases. In order to accurately calibrate dosage, it is essential that three factors be held constant. These are: speed of the delivering carrier, spacing on the injection chisels, and weight or viscosity of the mixture. With these factors held constant, various orifice plates can be used at given pressures to maintain very accurate calibration.

When these chemicals are injected into the soil at a depth of 6 to 8 inches they are found to create semi-oval, linear plane diffusion patterns which overlap at 10 to 14 inch chisel spacings. Penetration of the chemical is enhanced and results are achieved at lower dosages.

Application Method

Application equipment which embraces all the above features is in daily commercial use and greatly increases the speed and economy of application in comparison with the so-called raised tarp method, already described. The fumigant is injected into the soil through nine chisels spaced 12 inches apart. Mounted on the same tool bar is a disc which opens a trench on the outside of the area to be treated. By making a second pass in the opposite direction an 18-foot area is thus treated with a trench opened on each side.

Immediately after application a 2 mil polyethylene tarp, 20 feet wide is rolled over the treated area. The edges of the tarp are placed in the trench in a vertical manner and the trench is filled in. A complete seal is effected. No appreciable fumigant is lost as the area is covered and sealed within 30 minutes.

An experienced crew can apply and cover three to four tarps, 800 feet long, in one hour. The following day the area adjacent to the tarp is treated in the same manner, the only exception being that only one trench is opened at the outer edge of the newly treated area. The tarp that was layed the previous day is flopped over this area and sealed. If treatment is desired in two days, tarps should be spaced at 36 foot intervals so that the first tarp when flopped meets the area covered with the second tarp, and so on. The tarp can then be moved to the next area to be treated. In general, a 2 mil tarp will hold up through six to ten flops before it must be replaced.

Automatic Tarping

(3) Chisel injection automatic tarping: The theory of application is the same here as in the previous method except that a rather recently perfected machine attached to the tool bar is used to lay the tarp automatically as the chemical is injected. With this machine we treat a 9 foot, 6 inch swath, covering with 11 foot wide 1 mil poly film. The fumigant is injected, the trenches opened, the tarp laid and the edges buried in one operation. This is the ultimate for a large scale operation.

The factors governing which method should be used are time, available labor and area to be treated. In the preparation of a golf course, if only greens are to be treated and weeds are to be controlled, we recommend the "raised tarp method". Polyethylene film can be obtained in widths up to 40 feet and 100 feet long, permitting covering of a large area at one time. In this way, the soil can be prepared for seeding before fumigation and requires a minimum of work to smooth out footprints and other irregularities when the tarp is removed. Use of tractor equipment on greens presents a problem of compaction.

If fungus diseases are known or suspected to exist, chloropicrin can be very easily and effectively applied in areas such as golf greens with a hand operated applicator known as the Fumigun. Experience has shown that no golf green should be established without the use of fumigants in the soil preparation.

Michigan State Field Day

Michigan State U's turf field day is scheduled for June 25 at the University farm in East Lansing. James B. Beard, assistant professor in the farm corps dept., is in charge of arrangements.

Golf Guide is a 92 page booklet to be published this month by Snibbe, Mott & Assoc., New York 1.

THE ECONOMY OF NITROFORM®...

4: Bermuda Loves Nitroform

Now bermuda grass turf should be growing lustily. From now until frost it will be hacked, gouged and pounded until one wonders if it can possibly survive. Never will there be a better time to cultivate deeply, remove unnecessary thatch and mat, and apply a generous supply of Nitroform nitrogen. Tees, fairways, athletic fields, lawns, parks and cemeteries in most areas can receive a full season's supply (greens may take theirs in 2, 3 or 4 applications). Talk about economy—this is it! Not only will this season's needs be satisfied, but there will be ample food left over to fill rhizomes with reserves to carry the turf through the winter, ready to burst with life the following spring. This is timing in its ultimate perfection. The soil organisms "feed" nitrogen to the grass *AS NEEDED!*

Labor is released to do other important tasks. The superintendent is relieved of repeated decisions that hung over him when light, frequent applications were necessary.

Continuing research in the South attests to the economy of Nitroform in seedbeds for warm-season grasses. A generous supply incorporated deeply along with lime (where needed), phosphorus, and potash starts grass quickly and keeps it growing *continuously* with no "hunger breaks." The economy lies in producing playable turf in the shortest time with fewest weeds. Labor and other costs for maintenance feeding while grass is developing into turf are *zero*. Later, when turf is in play and there is the need, maintenance feeding with Nitroform can begin, balanced *as needed* with other nutrients.

When warm-season turf has been started with Nitroform in the seedbed, and has had one or two maintenance feedings with Nitroform, you will feel as we do, that Nitroform was made for bermuda, zoysia and other southern grasses. It will be hard to believe until you have experienced it.

Sandy soils—but that is another part of our story.

New Development In Slow-Release Fertilizers

By O. R. LUNT
University of California, Los Angeles

There have been several recent developments in slow-release fertilizers. These materials supply nutrients continuously over an extended period in contrast to water soluble fertilizers which are immediately available after incorporation in moist soil. Slow-release fertilizers are not subject to rapid leaching loss and do not easily burn plants from over-application.

The major need for slow release materials is to supply nitrogen or potassium. Phosphorus does not leach rapidly, as a rule, even from sandy soils, and calcium and magnesium are available from dolomitic limestone and sulfur from gypsum in slightly soluble forms.

Long lasting characteristics for fertilizers may be achieved by the techniques listed in Table 1 (p. 58) which lists both new and some old materials. General comments on the properties of these materials and their potential utility in turfgrass management follow.

1. Membrane coated fertilizers: The Archer-Daniels-Midland Co., Minneapolis, has developed a process for coating individual granules of water soluble fertilizer. When coated fertilizer is placed in moist soil, water passes through the membrane, dissolves some of the fertilizer which in turn slowly diffuses out through the membranes. The rate of release from the coated granule is determined primarily by the thickness of the membrane. For materials having a coating thickness of about 15 per cent by weight, two to three months or longer are required to exhaust the fertilizer. The rate at which the fertilizer is released is only moderately influenced by soil temperature (in the temperature range which supports grass growth), not significantly influenced by soil moisture until the soil approaches the air dry state, and is not significantly influenced by soil pH or microbiological activity.

Surface applications tend to last much longer than when the fertilizer is incorporated in soil because when on the surface, the fertilizer tends to be dry much of the time. The ideal way to use coated fertilizers on closely mowed putting greens would be to work it into the holes made by aerification. It is possible to "mow off" a portion of an application of coated fertilizer if a dense turf is subsequently closely mowed after the fertilizer application. The use of smaller size granules now available, appears to have eliminated those problems.

Heavy Applications Safe

Very heavy applications of coated fertilizer may be made safely to turfgrass. Twelve pounds of actual nitrogen per 1,000 square feet may be applied in a single application, if desired. If heavy applications are made, it is necessary that a small amount of deep leaching occurs from irrigation; otherwise, salinity conditions could develop.

Since various fertilizer sources or mixtures may be coated, complete flexibility in ratios of nitrogen or potassium to be used are possible. There seems to be little need for coated phosphorus fertilizers.

Give Promising Results

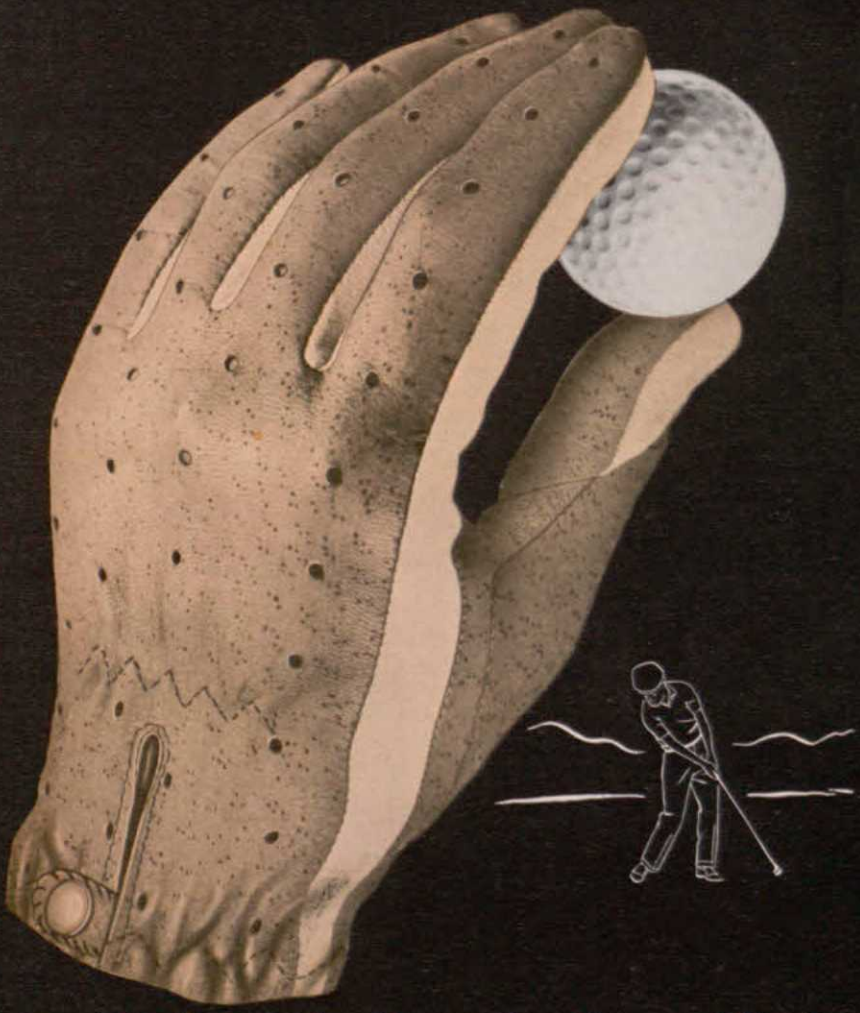
In a number of field trials on grass, coated fertilizers have given very promising results, maintaining excellent growth and color of grass for periods of several months. Coated fertilizers are, in the opinion of the writer, a highly attractive development for the control of mineral nutrition where nitrogen and potassium are easily subject to leaching losses as in high-sand content putting greens.

Coated fertilizers are now commercially available from several distributors in the U. S. Their competitive position with other special purpose fertilizers will be strongly influenced by price.

2. Slightly soluble fertilizer minerals: Limestone, gypsum, gypsite and various phosphorus materials fall in this category and have been used for years to supply calcium, magnesium, sulphur, and phosphorus. Until recently, sources of slightly soluble potassium and nitrogen minerals have not been available.

Metal ammonium phosphates*: A num-

* *The potential of metal ammonium phosphates as fertilizer materials is being developed by the W. R. Grace Co. These materials are currently commercially available in various parts of the U. S.*



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PEORIA, ILLINOIS

NEW B7B STRETCH GLOVE ILLUSTRATED

ber of divalent metals including magnesium, ferrous iron, zinc, manganese and copper form compounds of the general composition $MeNH_4PO_4.H_2O$ which have solubilities of a fraction of a gram per liter. The magnesium mineral has the greatest potential as a fertilizer source for nitrogen. The fertilizer grade of this mineral has 8.3 per cent N and 43 per cent P_2O_5. When the mineral is placed in water, it dissolves until saturation is reached. Then no more dissolution occurs. The rate at which equilibrium is approached is strongly influenced by the amount of surface area of the fertilizer.

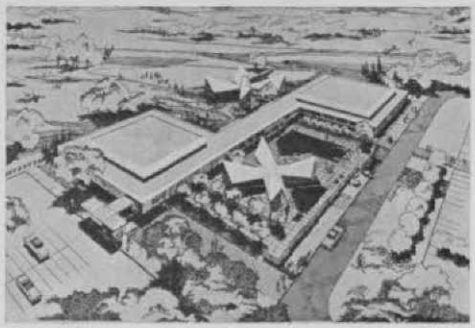
Thus, powdered magnesium ammonium phosphate dissolves more rapidly than would coarse granules, although both produce saturated solutions of the same concentration. The equilibrium is upset if soil reactions or plant absorption remove the soluble products. Thus, the mineral dissolves more under acid than alkaline conditions (magnesium and phosphate are removed from solution under acid conditions), more under wet than relatively dry conditions, and more when nitrification is progressing rapidly than when it is not.

Size and Placement

Two major determinents for the availability of nitrogen from magnesium ammonium phosphate are particle size and mode of placement. The larger the particle size the more slowly is nitrogen made available and surface application generally extends the period required to dissolve the mineral compared to incorporation in the soil.

The high phosphorus to nitrogen ratio in the metal ammonium phosphates is disadvantageous for maintenance programs. For single or occasional application use, the metal ammonium phosphates are outstanding for their ability to supply nitrogen at steady rates for prolonged periods. If relatively large granules are used, it is possible to supply substantial quantities of nitrogen for periods of more than a year from a single application. This makes the material well adapted for use in establishing new landscape materials including turfgrass. As noted previously the fact that P_2O_5 is five times as high as nitrogen militates against frequent and repeated use of magnesium ammonium phosphate because of the tendency to develop unnecessarily high levels of phosphorus in the soil.

Use of metal ammonium phosphates as sources of micronutrients is also of some interest. The minerals are effective sources



The clubhouse of the Lakepointe CC, St. Claire Shores, Mich., will be of contemporary design with a garden court and swimming pools linking the units. The unit in the upper right hand corner will be built first.

of certain micronutrients and may well be advantageous sources of these minerals. There is at the present time a want of research information on their use for supplying micronutrients. Also of interest is the possible use of magnesium potassium phosphate as a long-lasting potassium source. The possibility seems attractive although little research has been done with the potassium mineral.

Cut Down on Leaching

Glasses:** Glass compounds containing about 36 per cent potash have been developed which supply potassium at a satisfactory rate for prolonged periods. The high cost of these sources of potassium has precluded their extensive use but they are effective under conditions where leaching losses are normally very high. Glasses which supply various micronutrients have also been developed. Where micronutrient problems with boron, copper, manganese, molybdenum or zinc are believed to exist, consideration might be given to experimentation with Fritted Trace Elements as the glasses are called. Since very serious injury may result from excessive application, evaluation should only be undertaken with qualified technical supervision.

Colemanite: In those sections of the country where boron deficiency occurs, the use of Colemanite as a boron source is finding favor. Colemanite is a boron mineral of relatively low solubility.

3. Synthetic organic nitrogen sources which are slowly mineralized:

Urea Formaldehyde: Although urea-

***The Ferro Corp., Cleveland, Ohio has developed glasses for supplying trace elements and potassium.*

1927 *1,300,000 golfers—and, compared with today, what miserable scores they carded. Then True Temper invented the Step-Down-Design Steel Golf Shaft.*

1963 *12,000,000 golfers—many with ferocious handicaps. And, over the years, True Temper has made some 50 improvements in step-down design. Have you tried new clubs lately?*

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STEP-DOWN-DESIGN STEEL GOLF SHAFTS · GENEVA, OHIO · FINEST QUALITY IN GARDEN, LAWN AND FARM TOOLS · SHEARS · SHOVELS · HAMMERS, HATCHETS AND AXES · FISHING RODS AND REELS · GOLF CLUB SHAFTS · RAILROAD PRODUCTS

Technique for achieving slow-release effects of fertilizer	Fertilizer materials	Fertilizer elements which may be supplied by this technique
1. Membrane coating of soluble fertilizer	Most fertilizers	All
2. Slightly soluble minerals	1. Metal ammonium or potassium phosphates	Nitrogen, Magnesium, Zinc, Manganese, Copper, Potassium
	2. Phosphorus fertilizers	Phosphorus
	3. Glass frits	Potassium, Copper, Zinc, Boron, Manganese, Molybdenum
	4. Limestones	Calcium and Magnesium
	5. Colemanite	Boron
	6. Gypsum	Calcium and Sulfur
3. Synthetic organic nitrogen sources which are slow to mineralize.	1. Urea-Formaldehyde	Nitrogen
	2. Crotonylidenediurea	Nitrogen
4. Natural organic nitrogen sources which are slow to mineralize	Activated sewage sludges	Nitrogen
5. Ion exchange fertilizers		All

Table 1 A listing of various techniques for achieving slow-release fertilizers and some of the materials available with elements which they supply.

formaldehyde materials have been commercially available for about eight years, there seems to be considerable misunderstanding regarding their properties and use on turfgrass. About 25 per cent or more of the nitrogen in commercial urea formaldehyde (U-F) is cold water soluble. This fraction, which is of lower molecular weight, is mineralized to nitrate or ammonia rather rapidly under favorable conditions, the bulk being mineralized in about 4 weeks. The remaining fraction is mineralized at a relatively slow rate.

Our experience with greenhouse crops as well as turfgrass indicates that in general about 6 or 7 per cent of the cold water insoluble fraction is mineralized per month in typical management situations when temperature conditions are favorable. Incubation studies, however, often show the cold-water-insoluble fraction to mineralize at the rate of about 7 to 11 per cent per month. Of course, mineralization rates are subject to all the influences which would affect microbiological activity — i.e., temperature, aeration, pH etc.

Residue Must Be Built Up

Our experiences and studies, which cannot be reported in detail here, indicate that very good slow-release performance can be obtained from U-F materials on turfgrass under year round growing conditions. We have not had experience in long term management programs with U-F where a dormant winter season occurs. The basic requirement for a successful U-F program is the development of a large enough reservoir of the residual R-F fraction so that the 6 or 7 percent mineralization per month meets the needs of the planting. The scheme is analogous to living off the interest of a bank account. The plan works well if the principal is large enough. We estimate that about 20 or 25 lbs. of nitrogen in the form of "residual" urea-formaldehyde per 1000 square feet is required to produce an adequate, steady supply of available nitrogen in putting greens.

The amount of residual U-F required

(*Continued on page* 80)

TURF DISEASE

KILLER WANTED

KILLED Dollar Spot
In May with two applications of 2 oz. per 1000 sq. ft. three days apart.

KILLED Copper Spot
In June with two applications of 2 oz. per 1000 sq. ft. three days apart.

KILLED Brown Patch
In July with two applications of 2 oz. per 1000 sq. ft. three days apart.

KILLED Leaf Blights
In August with three applications of 2 oz. per 1000 sq. ft. three days apart.

WANTED BY EVERY SUPERINTENDENT: kromad®

KROMAD *is* a killer, a lone killer...of five major turf disease organisms. And, as is said of most killers, it kills by pattern. When turf diseases get out of control, golf course superintendents depend on the killing pattern of KROMAD—2 oz. per 1000 sq. ft. three days apart for two or three applications.

After this broad-spectrum fungicide has completed its curative job, superintendents revert to the preventive pattern—2 to 3 oz. per 1000 sq. ft. every 5 to 7 days. Curative or preventive, KROMAD is exceptionally safe...will not harm the finest turf, even when applied at several times the recommended rate.

KROMAD is economical. Broad-spectrum control of a wide range of diseases eliminates buying, stocking and applying several different fungicides, saves time because it eliminates the difficult task of positively identifying and individually treating each disease.

KROMAD also offers other **plus** values. Urea content stimulates growth, but doesn't interfere with regular fertilizer programs. Iron content helps grass develop stamina and a rich green color. Fungicidal dyes in KROMAD assist in disease control, add color to diseased or off-shade turf and provide a check on uniformity of coverage during application.

Get KROMAD...available from over 100 Mallinckrodt distributors throughout the country. Write for the complete list of distributors. You'll be happier, your greens healthier ...with KROMAD.

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Steel pro shop at Brown's Run is 28 feet wide and 44 feet long, was selected by architect because it is easily maintained. Interior walls are finished in wood panelling.

Modernization—the Easy Way

Brown's Run CC Replaces Its Pro Shop and Golf Car Building with Easy to Maintain Steel Structures

Officials of Brown's Run CC in Middletown, O., are enthusiastic about their recent modernization program which included construction of a handsome pre-engineered steel pro shop and a much needed golf car storage building.

Built in less than six weeks during the winter, the pro shop is of contemporary ranch style design and houses complete sales and service facilities. The exterior of the golf car storage building is finished with white, factory applied baked enamel. Located near main club buildings and the first tee, it replaces an inconveniently located storage area in an old barn.

Two Favorable Factors

Architect E. E. Loewe selected the Armco steel pro shop building over a structure of conventional materials because of the practical aspects of its pre-engineered design. Its cost was easily determined initially and maintenance expense, it was seen, would be almost nil.

Walls and roof of the pro-shop were erected in two days during mid-winter. This permitted interior work, which included installation of attractive wood panelling, to proceed regardless of weather. Total construction took only six weeks. The building cost around $10,000.

Needed Better Shelter

Inadequate storage facilities for the rapidly increasing number of members' cars forced Francis Marzolf, pro at Brown's Run, to seek better methods of sheltering the equipment. Versatility and economy were prime factors in the selection of the pre-painted steel building which is 24 x 76 x 8 feet and capable of storing 36. Total cost of the structure, including site preparation, electrical outlets to recharge car batteries, and concrete foundation, was about $5,000. The installation was completed in one week.