New Development In Slow-Release Fertilizers

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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.*

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.*

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

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to achieve satisfactory performance depends on management conditions, particularly the amount of leaching. Once the proper residual U-F level is established annual application rates are about the same or less than would be required with other types of fertilizers and the interval between applications may be between three and five months. The necessary residual level of nitrogen cannot be achieved in a single application, but must be built up gradually by a series of heavy applications extending over about 6 or 9 months.

Other Synthetics

Crotonylidenediurea (C-diurea) **and other synthetic organic nitrogen sources:** Several other synthetic organic nitrogen sources in addition to urea-formaldehyde have been investigated in recent years. Among these are acetylenediurea, oxamide and crotonylidenediurea (C-diurea). Of these, the latter seems to be the most promising. It is in commercial production in Europe by Badische Anilin and Soda Fabrik. Published information on C-diurea indicates that it has rather low initial availability but undergoes relatively rapid nitrificiation after about a month and continues to yield substantial quantities of nitrogen for more than a year. Studies are currently in progress to ascertain if the material differs significantly in its properties from commercial sources of U-F.

Becomes Slowly Available

4. Natural organic nitrogen sources which are slowly mineralized:

Activated sewage sludge: One of the most widely used fertilizers on high quality turf has been activated sewage sludge. Nitrification studies have shown that usually about one-third to one-half of the nitrogen in activated sewage sludge is mineralized in four weeks time when conditions are favorable. The remaining fraction is very slowly available but does make an appreciable contribution as residual levels build up. As compared to urea-formaldehyde, the more readily available fraction is more quickly available than that of U-F but the slowly available fraction appears to be less available than that of U-F.

5. Ion exchange fertilizers: This technique involves supplying the fertilizer elements as exchangeable ions absorbed on resins. It has been shown that nutrients can be effectively supplied to plants for periods of several months by this means in spite of conditions which would normally leach soluble minerals. The cost of providing for slow-release fertilizers in this fashion is high and the technique appears destined to remain of academic interest as far as turfgrass is concerned until lower cost exchange resins are developed.

Installation and Maintenance of Miniature Greens

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not be used, use a tamper or walk back and forth several times.

Can new felt be laid over the old?

No! The old felt should be removed by scraping or with a blow torch to heat the adhesive so that the old carpet will "peel" back. A wire brush is used to complete the job. Weather during the closed season will remove much of the old adhesive and bits of carpeting.

Should the felt carpet be covered during bad weather?

Not if good material is used. All-hair felt combinations naturally withstand rain, snow, ice or extreme heat and will not mildew or rot.

What is the average useful life of putting course felt?

Many operators prefer to change greens every year. They find that after a year's heavy service, wear spots and uneven surfaces begin to appear. The cup area, for example, is seldom stepped on. A rise or slope around the cup results.

What special cleaning is needed?

None. A simple broom or brush removes most surface dirt, mud, etc. Waterproof tar or similar spots are left to wear off with the flow of traffic.

After a heavy rain, how long must you wait before felt greens are playable?

Play can start almost immediately on a good quality felt after fairways and greens are squeegeed. Actually, squeegeeing is a safety factor since wet felt can be slippery.

How do you patch a bad break or hole caused by club damage or spike rips?

Avoid patching where possible, especially in tread-worn areas where it is difficult to match felt thickness. Fold back the ruptured piece, blow out the dust and dirt, then apply cement as required. Return flap and press down with your fingers around the edges, tucking in the edges and pulling surface fibers together to camouflage the tear.