Chemical Company, qualifies as a ureaformaldehyde fertilizer and not just simply as a UF reaction product. This is because Nitroform has at least 60% water soluble nitrogen (actually 66%) and the water insoluble nitrogen does not test less than 40% active by the nitrogen activity index (actually 40%).

Activity index indicates the amount of water insoluble nitrogen which is soluble in boiling water. An activity index of 40 means that 40% of the methylene ureas are soluble in hot water, while the remaining 60% are insoluble in hot water. Length of nitrogen release is 2 years. Lebanon Chemical also manufactures a ureaformaldehyde.

Isobutylidene Diurea(IBDU) was first marketed by Estech, Inc. in the late 1960's. IBDU is produced by reacting urea with isobutyraldehyde. For turfgrass fertilization, IBDU is sold as a granule in 2 sizes, fine (0.5-1.00 mm diameter) and coarse (0.7-2.5 mm). For container-grown and landscape plants, "briquettes" of IBDU are also available, called Woodace. They last in the soil from one to three years depending upon size, and are complete fertilizers.

Urea is released from IBDU through the hydrolytic action of water. The primary factors which influence the rate at which nitrogen is released from IBDU are **soil moisture and particle size**. Increasing soil moisture and decreasing particle size will increase the rate at which nitrogen is released.

IBDU in granular form contains 31% nitrogen of which 85-90% is insoluble.

Slow-release nitrogen is produced by encapsulating quick-release nitrogen with an insoluble coating. The soluble nitrogen is released through tiny pores as the coating is broken down in the soil. A mixture of variable coating thicknesses provides continuous release of soluble nitrogen for a controlled period of time. Only two slow-release nitrogen sources are commercially available —sulfur-coated urea and Osmocote®.

Sulfur-Coated Urea(SCU) is produced by coating granular or prilled urea with molten sulfur. The manufacturing process may also include the application of a sealant (microcristalline wax) and a conditioner (diatomaceous earth).

Degradation of the coating and diffusion of nitrogen through pores or imperfections in the coating are responsible for release of nitrogen. Because of varying coating thicknesses and imperfections, the rate at which nitrogen releases also varies. **Soil moisture** is the major factor which influences release of nitrogen. Increasing soil moisture will speed nitrogen release.

A prediction of the rate at which nitrogen is released from SCU is known as dissolution rate. Dissolution rates range from 20% to more than 80%. Nursery grade SCU has a lower dissolution rate than turf grade. For SCU coated with microcrystalline wax a dissolution rate of 25-40% has given good initial turfgrass response. Ask the manufacturer for the dissolution rate of SCU to determine an accurate N release rate.

Although a 2-4 month residual is claimed for surface applications to turfgrass, the nitrogen release rate may be as great as one year, depending on placement and product used. Commercial products range from 32% to 38% nitrogen. SCU is available from Canadian Industries Ltd., Ag Industries Manufacturing Corporation (a division of Lesco Inc.), and O.M. Scott and Sons.

Osmocote® has been available to the horticultural and landscape industry since 1967. Osmocote is manufactured by the application of a plastic, semiporous coating to prilled soluble fertilizer sources such as ammonium nitrate, ammonium phosphate, urea and calcium phosphate.

Nutrients are released from Osmocote by diffusion. Water enters the plastic shell, dissolves the soluble nutrients which then diffuse into the soil for plant uptake. **Soil temperature** will significantly influence the rate at which nutrients are released. Warmer soil temperature increases the release rate, while cooler soil temperatures decrease the release rate.

Nitrogen release rate varies from three months to one year plus, depending on the nitrogen source(s) used and placement of the fertilizer. Osmocote is available through Sierra Chemical Company.

Quick-release nitrogen sources are all soluble in water and are either available for root uptake in their present form or are readily converted to available forms in the soil. Inorganic nitrogen fertilizers (sources which do not contain carbon) such as ammonium nitrate and ammonium sulfate are quick-release. Urea, although technically organic, is soluble and possesses many of the same characteristics as inorganics.

In general, the quickly available nitrogen sources are less expensive than controlled-release sources and have the following characteristics:

1 Readily soluble in water
2 Immediately available for absorption
3 Can cause growth flushes
4 Short soil residual
5 Leach and/or volatilize
6 High burn potential.

Recent developments in ureaformaldehyde reaction products have provided quick-release nitrogen with a burn potential much lower than for other soluble nitrogen sources. A discussion of these products is included in the section on Ureaformaldehyde Reaction Products.

New products

Oxamide—Current projections by Estech, Inc. are that Oxamide will be marketed in 1985. Oxamide, which is a diamide of oxalic acid, is made from hydrogen cyanide. Tests have been conducted with both powder and granular forms.

The method by which nitrogen is released from Oxamide is chemical hydrolysis by water. **Particle size** influences the rate at which nitrogen is released from Oxamide—the larger particle releases more slowly.

Research has shown that Oxamide has a residual of from 60 to 100 days although the larger particle has shown nitrogen release up to six months. Oxamide contains 31% nitrogen.

Triamino-triazine/urea under development by Melamine Chemicals, Inc. is a homogeneous granule of triamino-triazine (66% nitrogen) and urea (46% nitrogen). Triamino-triazine is a crystalline powder produced by heating urea under pressure in the presence of a catalyst.

Both microbial decomposition and chemical hydrolysis are responsible for the release of nitrogen. **Soil temperature, moisture and pH** all influence the rate at which nitrogen becomes available from this product. The triamino-triazine portion of the fertilizer is slowly broken down in the soil. There is an initial lag of over 60 days before nitrification followed by a controlled release for a period of one to two days.

A triamino-triazine/urea product with an analysis of 60-0-0, containing 1/3 urea, 2/3 triamino-triazine by weight, is currently available for forest and rice fertilization. Although still being tested, this new source of nitrogen may prove to be a valuable alternative to conventional nitrogen sources used in fertilizing turfgrasses and landscape plants.

Nitrification Inhibitors—As mentioned previously, substantial losses of nitrogen can result from volatilization and leaching. A concept that has been practiced with fertilization of field crops is the use of a nitrification inhibitor.

The objective is to slow the nitrification process for sources of quick-release nitrogen which are ammonium-based or ammonium-forming such as ammonium nitrate, ammonium sulfate and urea.

Nitrification is a two-step process where ammonium is converted to nitrite then nitrate by soil bacteria. The nitrification inhibitor reduces the bacteria responsible for the conversion process which keeps the nitrogen in the ammonium form. In the ammonium form, the nitrogen is less subject to losses by leaching. Likewise, maintenance of nitrogen in the ammonium form reduces the potential for denitrification (which is loss of nitrate as a gas) which improves the overall efficiency of the nitrogen source.

Nitrapyrin, marketed as N Serve by Dow, is a nitrification inhibitor which is currently registered for use in corn, wheat, sorghum, cotton and rice. Because nitrapyrin is volatile, it must be incorporated into soil during or following application. Dow is currently testing nitrapyrin as a nitrification inhibitor for turfgrass. Lebanon also has an inhibitor for turf.

Another interesting concept developed to reduce the loss of nitrogen from volatilization is the addition of soluble magnesium or calcium to urea.

When applied to soil, urea is converted into ammonium carbonate. In this form, the ammonium ion can be changed to ammonia and lost as a gas. When magnesium chloride is included with urea, ammonium chloride—instead of ammonium carbonate—is formed and is less susceptible to ammonia loss.

Although still being evaluated, NVN is a urea-magnesium solution marketed for turfgrass fertilization in 1984 by Great Salt Lake Minerals and Chemicals Corporation. Further testing and experience with this product should help to document the practical application of this product.

Phosphorus

Phosphorus is especially important in seedling growth and is utilized in carbohydrate conversions, energy transfer and is a constituent of nucleoproteins and phospholipids. Phosphorus helps maintain a desirable pH in cells and contributes to root development.

Phosphorus deficiencies are most often encountered in seedlings. Leaves or needles turn a dull green becoming reddish-bronze to purple, especially along margins in cold weather. Some phosphorus is provided by soil minerals and soil organic matter but it is very slowly available from these sources.

Since phosphorus moves very little through soil, supplemental phosphorus tends to accumulate near the application site, moving no more than a few inches in 50 years. Plants take up phosphorus primarily in the

continued on page 46

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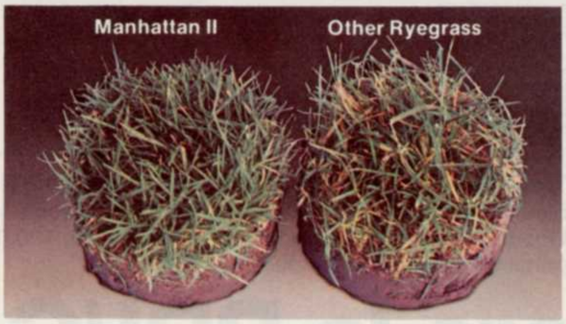

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Circle No. 124 on Reader Inquiry Card

The grass along the fence in the photo at left was killed with a fast-acting systemic post-emergent herbicide. Obviously, no professional groundskeeper could abide this ugly mess, so the dead vegetation has to be removed with expensive hand labor. The systemic product is recommended for lawn renovation so, naturally, vegetation will grow back as new seeds germinate, resulting in an endless cycle of retreatment, ugly dead vegetation and more hand labor. Clean up a fence line with Dyclomec and vegetation will never again be a problem, because an annual pre-emergent application of Dyclomec will form a vapor barrier and keep the area absolutely clean.

Dyclomec with its pre-emergent and post-emergent action is ideal for vegetation control in mulch, or bark around roses and ornamentals, or in flagstone and gravel walkways. It works its way down to the ground and forms a vapor barrier which provides season-long weed control and maximum safety to desirable plants.

Dyclomec turns Problem Areas into Beauty Spots

... and the vapor barrier eliminates repeated investment of hand labor to clean out dead vegetation.

Dyclomec is surely the most efficient herbicide that has ever been offered to professional landscapers. In fact, it is called the *landscaping herbicide*.

Now, at last, the groundskeeper can easily and economically achieve that manicured look, which consists of contrast. Of sharply defined areas where immaculate turf is contrasted with areas of beautiful, naked earth. Where ornamentals grow in an area of beds that are free of any distracting growth.

Until the advent of Dyclomec, such pristine landscaping could only be achieved with repeated investments of hand labor to clean out dead vegetation resulting from an endless cycle of regrowth and retreatment with a systemic herbicide.

But once an area has been cleaned up with Dyclomec, hand labor to remove dead vegetation will never again be necessary because an annual application of Dyclomec will keep the area absolutely clean. How is this possible?

On the page at the right are step-by-step illustrations of how Dyclomec works. Understanding its principle will help you discover the many labor-saving, money-saving ways it can help you in landscape maintenance.

We urge you to read it carefully and call us toll free if you have any questions.

Dyclomec Applicator for Uniform Distribution

Because proper distribution of Dyclomec is important, this patented Acme Spred-Rite® G Spreader is the ideal tool. Granules are gravity-fed through deflector spikes that give a uniform pattern. Hold the head high for a wide swath; lower for a narrow swath; remove it for the finest line of control. Regulate flow with interchangeable orifice disks. Spreads any granular material. Lightweight. No moving parts.

How Dyclomec controls weeds without harming ornamentals:

Now available in both 50 and 25 lb. bags.

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PROFESSIONAL TURF PRODUCTS

pbi/gordon corporation

Call Gordon's Technical Service Department

If you have any questions about where and how to use Dyclomec, we invite you to call us. Our technical people have a combined experience of 85 years in working with the Dyclomec chemical.

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DYCLOMEC™

BARRIER™ LANDSCAPING HERBICIDE

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This 4-color, 2-page ad for Dyclomec® Landscaping Herbicide in *Weeds Trees & Turf* produced 1,757 inquiries. Even more impressive: Readex reader interest score for the ad was 68%...the highest score ever measured in *Weeds Trees & Turf*. And in the upper 3% of over 400,000 ads that have been measured by Readex. The ad was prepared by Eatough Associates.

Here is PBI/Gordon's recipe for advertising that sells:

PBI/Gordon's advertising successes over the last 10 years are legendary.

...Trimec® Turf Herbicide advertising has won numerous readership awards, and it has become the number one broadleaf herbicide in the professional turf market.

...Exhalt® 800 advertising has helped Gordon dominate the sticker-extender market among golf courses.

...and now comes Dyclomec Landscaping Herbicide, breaking all sales records for a new product.

What is Gordon's secret?

"It's as simple as one, two, three," grins George Walter, PBI/Gordon's ebullient Vice President of Marketing.

"First, develop a useful product with demonstrable points of superiority.

"Second, create an advertising theme that optimizes what can be said for the product.

"And, third, give the advertising dominant exposure in the dominant medium."

Indeed, Dyclomec is a unique, useful product: precise; economical; growing-season-long control of vegetation for landscaping and nurseries; can be applied anytime except when the ground is frozen.

The advertising theme, *Dyclomec turns problem areas into beauty spots*, certainly optimizes the story.

And *Weeds Trees & Turf* is the dominant medium in the turf market.

"*Weeds Trees & Turf* is our number one medium," continues George Walter. "It has outstanding reach and readership, and it sure does bring in the sales."

A GREAT MEDIUM TO GROW PROFITS IN

WEEDS TREES & TURF

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orthophosphate (H_2PO_4-) form. Although soils normally contain relatively large amounts of phosphorus, much of it is in forms not available to plants

Phosphorus availability is influenced by **soil pH**. At a pH below 5.5, iron and aluminum form an insoluble complex with phosphorus that is not available to plants. At a pH above 7.5, calcium combines with phosphorus to form insoluble compounds such as calcium phosphate, $CA_3(PO_4)_2$. Phosphorus is most available between pH 6.0 and 7.0.

The most common phosphorus sources for granular application are the superphosphates with a P_2O_5 equivalent of 20% to 48%. Soluble phosphorus sources include monoammonium phosphate (11-48-0) which is recommended for alkaline soils, and diammonium phosphate (18-46-0). Liquid ammonium phosphate (10-34-0) is often used where bulk tank storage is feasible. Monopotassium phosphate (0-52-34), a soluble, granular product, has an excellent potential as fertilizer because of its high analysis and low salt index, but high cost of production has limited its use.

Potassium

Potassium is found in all plant parts in relatively large quantities and functions in catalyzing reactions, regulating transpiration, and aiding in the translocation of materials between cells. Although more research needs to be done with turfgrasses and woody plants, potassium is thought to influence rooting and increase resistance to heat, cold, drought, and disease.

The effects of potassium on plants are more subtle than the effects of nitrogen because they are not normally expressed visually in terms of growth rate or leaf color. Potassium deficiencies may restrict the translocation of carbohydrates and nitrogen metabolism and are evidenced first as marginal and interveinal yellowing of older leaves. Leaf tips may roll, turn brown and wither; growth is often stunted.

Potassium mobility in soils is less than that of nitrate but greater than that of phosphates. The available form of potassium (K+) is strongly absorbed by clay particles which prevents excessive leaching except on sandy soils.

The most common potassium fertilizer is potassium chloride (0-0-62), although potassium sulfate (0-0-54) is often used in arid regions where chloride is a problem or in liquid fertilization programs because of its lower burn potential. Potassium sulfate has a lower solubility and may contain insoluble silica fractions. Potassium nitrate (13-0-44) is an excellent fertilizer but generally is not priced competitively with the chloride or sulfate forms. Monopotassium phosphate (0-52-34), as mentioned earlier, has excellent potential as a fertilizer but its use is limited because of its high cost.

MICRONUTRIENTS

With the exception of sandy soils, micronutrients are more likely to be unavailable in the soil than low in total amount.

Deficiencies of iron, manganese, zinc, copper and boron are sometimes found in certain plant species, especially in sandy or alkaline soils.

Micronutrients commonly deficient in sensitive species should be included in the regular fertilization program. Once deficiency symptoms have developed, however, foliar sprays or trunk injections and implants may be necessary to correct the deficiency.

Iron is the micronutrient most likely to be deficient throughout much of the United States and Canada. Iron is most commonly deficient in alkaline soils, although excessive levels of phosphate, manganese, zinc, and copper can produce iron deficiency. Waterlogged soils also reduce the availability of iron.

Soil applications to prevent or correct micronutrient deficiencies include inorganic salts, chelates and sulfur. Results have not always been satisfactory due, in part, to insufficient applications of the amending agent, severity of the deficiency symptoms, and soil problems such as excess alkalinity or poor drainage.

Micronutrients in the form of nitrate or sulfate salts are often included in fertilizer formulations but not in sufficient amounts to correct a deficiency. In addition, micronutrient salts may become insoluble quickly in alkaline soils and, therefore, unavailable for absorption by plants.

Inorganic salts of micronutrients may injure turfgrasses at the rate recommended for woody plants and should be applied during the dormant period, preferably by subsurface application. Ferrous sulphate and ferric nitrate are available from agricultural and horticultural distributors.

Chelates remain more soluble in alkaline soils than inorganic salts and can be applied to the soil surface or injected into the soil. Chelates also are less likely to cause injury to plants than inorganic salts and last longer in the soil. However, the cost for chelated micronutrients is considerably higher than for inorganic sources.

Chelates are marketed under various trade names with formulations for different conditions and purposes. Sequestrene® from Ciba Geigy, Ferriplex® from Miller Chemical & Fertilizer Corporation, and XL Iron Chelate from Doggett Corp. are three chelated iron products. Recommended rates usually vary from 2 to 6 pounds per 1,000 square feet. Eagle-Iron®, produced by Eagle-Picher Industries, is effective for iron deficiencies in crops and is being tested for turf and woody plants. Select the proper product for a particular situation and follow directions on the label.

Acidifying agents, such as sulfur and sulfuric acid, are normally injected into the soil or placed in vertical holes. Depending upon the soil texture and pH, large amounts of sulfur may be required over a number of years to correct the pH of calcareous soils. To minimize the potential for injury to woody plants, 20 pounds per 1,000 square feet should be the maximum amount of sulfur applied at one time.

Turfgrass injury has been reported at rates above 5 pounds per 1,000 square feet. Attempts to acidify large areas of soil with existing landscape plants have generally been unsuccessful. Foliar sprays are especially effective on ericaceous plants, such as rhododendrons, to correct iron defi-

ciencies. Not all plant species, however, respond to foliar-applied micronutrients.

Applications are recommended just prior to or during active shoot growth in the spring, although applications later in the season may also be effective. Response to foliar treatments will vary depending upon the species, age and condition of the plant; time of year; micronutrient applied; and severity of the deficiency.

For best results, the plant should not be suffering from moisture stress, the leaf surfaces should be thoroughly covered and the humidity should be high enough to allow the spray to remain on the leaf in soluble form long enough to be absorbed. Both chelated and inorganic micronutrients are recommended.

Trunk injections and implants are recommended to correct micronutrient deficiencies in trees over 4 inches in diameter which do not respond satisfactorily to soil treatments. For trees which have begun to decline, the best results are usually obtained from trunk treatments in conjunction with soil applications of fertilizer. Once the deficiency has been corrected in the trees, attempts should be made to maintain adequate micronutrient levels in the soil to avoid repeated wounding of the trunks.

Injections or implants should be spaced 4 to 5 inches apart and as low as possible on the trunk. Since the outermost xylem (wood) rings are actively transporting water and dissolved minerals, capsules should be placed or injections made in this area. Capsules or materials which seal the injection hole should be inserted just below the bark tissue to facilitate proper wound closure.

The best results and the most rapid callusing occur when the treatments are made before growth starts in the spring.

In addition to commercially available injection and implant products, micro-nutrients can be injected with the same equipment recommended for Dutch Elm Disease, which is inexpensive and simple to use. For iron-deficient pin oaks, dissolve 1.5 to 2 grams of ferric ammonium citrate in one to two cups of water for each injection. Trees under moisture stress should not be treated with trunk injections or implants.

Companies making tree injection and implant products include Creative Sales Inc. and J.J. Mauget Co.

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THE 2-WHEEL GRAVELY SYSTEM

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FERTILIZER/PESTICIDE COMBINATIONS

The use of fertilizer/pesticide combinations has become an accepted practice among most turfgrass managers whether applying fertilizers in a dry or liquid form. In combining both fertilization and pest control in one application, both time and labor savings can be realized.

Fertilizer/pesticide combinations can include herbicides, insecticides and fungicides along with fertilizer. In dry form, a popular combination is a broadleaf herbicide(s) (ie 2,4-D, MCPP) impregnated on fertilizer. To optimize results, the label of dry fertilizer/broadleaf herbicide combinations will frequently recommend making the application following rain or irrigation or when a dew is present. This improves the adherence of the herbicide to the leaf surface of weeds and maximizes absorption.

Two important factors which can reduce the effectiveness of fertilizer/pesticide combinations applied in liquid form are **incompatibilities and alkaline hydrolysis**.

In addition to checking the pesticide(s) label, a wise precaution to tank mixing is to conduct a jar test for the compatibility of the components. **Incompatibilities** can lead to an unstable mixture and/or a chemical reaction between 2 or more tank mix components. These can result in one or more of the following: failure of the equipment to apply the tank mix, poor pest control or turf response, and phytotoxicity.

Alkaline hydrolysis is the degradation of a pesticide due to a high pH (greater than 7.0) of the water used to apply a pesticide. Some common lawn care pesticides which are subject to alkaline hydrolysis include organophosphate insecticides (Dursban, diazinon and Dylox), herbicides (bensulide), carbamate insecticides (Sevin), and certain systemic fungicides such as benomyl.

To determine if alkaline hydrolysis will effect the pesticide application, have the pH of the water source tested by using a pH meter or litmus paper. Should the water prove to be alkaline, check with the manufacturer of the pesticide(s) used for their suggestions on pH correction.

FERTILIZATION OF TURFGRASS

Traditionally, turfgrass managers have applied fertilizer during spring and fall using color and the amount of leaf growth as a guide to the rate and frequency of application.

Although promoting good color and stimulating shoot growth are important objectives, frequently overlooked are nutrient influences on carbohydrate reserves, root growth, and the plant's ability to tolerate disease and environmental stress. An understanding of the impact of fertilizer applications on these factors can give refinement to a fertilization program.

Timing applications

An important objective in timing fertilizer applications should be to build carbohydrate reserves and promote root development. The response of warm-season and cool-season turfgrasses differ in this respect.

The predominant **cool-season** turfgrasses (bluegrass, perennial ryegrass, fescue and bentgrass) initi-

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