A Basic Guide to Turfgrass Fertilization

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EACH year thousands of acres of land are converted into grass culture—grass for beauty, grass for erosion control, grass for recreation, grass for a thousand-and-one reasons.

No other plant is so intimately associated with people.

The large-seeded grasses such as wheat, corn, oats, barley, and rye contribute a large part of our diet—both solid and liquid. Also many of the same small-seeded species used for turf provide the basis for animal products. However, the fastest growing use of grass is in production of special-purpose turf.

Amazing national statistics can be quoted on the number of acres, the amount of labor, the tons of chemicals, the seed, etc., devoted to special-purpose turf culture. These are useful only if they prod the contract applicator into looking at what is happening in his area of operations.

Applications of fertilizer, insecticides, fungicides, herbicides, seed, growth-controlling chemicals, soil-stabilizing emulsions and materials, etc., necessary for the establishment and maintenance of special-purpose turf, would seem to provide the nearly year-round work needed to efficiently utilize machine and man power. CAs could not make a realistic *special-purpose turf* survey in their areas without getting excited about the potential!

Before spraymen get too excited they should remember that satisfaction and success is strictly dependent on, at least, minimum know-how. If you think a dead tree or two is trouble, try burning a football field a few days before homecoming or the golf greens on a famous course just before a big tournament! Fortunately, few operators will need to know the peculiarities of all or even most turfgrasses. While excellent books and bulletins are available on grass, such information must be tempered with keen observation of local conditions. Altitude, exposure, shading, drainage are some of the factors which markedly alter grass responses within small areas — even within a single yard.

We fertilize turf to improve its qualities of color, density, texture, and uniformity. Persistence, rooting depth, resistance to environmental hazards, salt, traffic, frost, insects, and disease are less obvious factors of quality that can be important. We cannot change the characteristics of grasses by fertilization, but we can greatly enhance color, density, uniformity, and resistance to some hazards by proper fertilization.

What is Fertilizer?

Fertilization is the addition of elements necessary for plant growth that are not naturally present in sufficient quantity or available form to support the desired rate of growth. Growing plants are mostly carbon (C), hydrogen (H), and oxygen (O) supplied from the air as carbon dioxide and from water. The other essential 13 elements needed by plants are the ones we fertilize to supply. Grass fortunately does not have a high requirement for any of the elements which are needed in very small quantities. For all practical purposes we can eliminate boron (B), chlorine (Cl), copper (Cu), molybdenum (Mo), and zinc (Zn) from our fertilizer element list. However, iron (Fe) and manganese (Mn), and particularly iron, can be troublesome. Soil normally contains plenty of these elements, but the wrong conditions will make them unavailable to plants. This situation is frequently caused by naturally alkaline soils or by overliming. Since liming is a form of fertilization, we can appropriately clear this up at this point.

Acid and Alkali Soils

The particles that make up the soil started out "neutral," just like common salt is neutral — composed of two dangerous elements, sodium (Na) and chlorine (Cl). When dissolved in water, compounds such as salt break up (ionize) to form positively and negatively charged particles called "ions." Positively charged ions are called "cations" or commonly "bases" and the negatively charged ions are called "anions."

The common bases in soils are calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+), sodium (Na^+), and ammonium (NH_4^+). The common anions are nitrate (NO_3^-), phosphate ($H_2PO_4^-$) ($HPO_4^=$), chlorine (Cl^-), bicarbonate (HCO_3^-), carbonate ($CO_3^=$), and sulphates (HSO_4^-) ($SO_4^=$). When rain falls on the soil, carbon dioxide in the soil air is dissolved to form carbonic acid. This acid combines with bases and the resultant salt solution is carried away in the drainage water. This process of leaching continually depletes soils of their bases and makes them more acid. This happens in areas where rainfall is high enough to carry salts out in the ground water. In our drier western states, dissolved salts are carried toward the surface as the water evaporates. Salt slicks and alkali soils are formed in this way.

When bases are leached from soil particles, the particles become negatively charged. This charge is satisfied by hydrogen ions (H^+). The soil particles are large complex anions which are weak acids when their charges are satisfied with hydrogen and complex salts when satisfied with bases. Not all soil particles are charged. Sand is frequently quartz and is not charged. Clay and humus are highly charged. Since soil particles are relatively large, they do not move, but the hydrogen and bases on

Contract turf fertilization, from lawn to industrial park, is big business in America. This article by turfgrass fertilizer expert Satchell shows CAs what processes are involved, and how to complete a job successfully.

their surfaces do dissolve (ionize) to some extent. If another base or hydrogen is dissolved in the soil water, the added base or hydrogen will slip in and satisfy the charge on the particle leaving the original base or hydrogen free to move out in the drainage water. This process is called "base exchange" or more properly "cation exchange" since hydrogen (not a base) plays such an active role.

pH and Acidity

One can measure the proportion of bases on soils indirectly by measuring the amount of hydrogen in the soil water. This is done easily and is the familiar pH determination — one of the most important tests available to turfmen. If the soil water contains more hydrogen than pure water, pH values less than 7 will be obtained and we call these soils acid or sour. Conversely, if less hydrogen is present, pH values greater than 7 will be obtained and the soils are called alkaline or sweet.

The optimum pH values for most grasses is between 6 and 7. Kentucky bluegrass, Bermudas, zoysia, and fescues do best near neutral to slightly acid (6.5 - 7) pH values. Bents and carpetgrass tolerate more acidity. Centipede grass is unusual and frequently shows iron deficiency at pH values much greater than 6.

Lime is used to raise the pH value of acid soils to a desirable range. About 100 lbs. of ground limestone per 1,000 square feet of area will raise the pH about 1 unit. Of course, clays and organic soils require more because of their higher exchange capacity and sands will require less. Sometimes we need to lower the pH values for plants that have high iron requirements, such as azaleas, laurel, rhododendron, blueberries, and andromeda. Sulfur or aluminum sulfate will do this. Twenty-five pounds of sulfur or 60 lbs. of aluminum sulfate per 1,000 square feet of area will lower the pH about one unit.

Secondary Nutrient Elements

Lime supplies essential calcium (Ca) and magnesium (Mg). Calcium (Ca), magnesium (Mg), sulfur (S), and iron (Fe) are required by plants in relatively large amounts. If proper pH values are maintained by limestone, there is little need to worry about calcium. Magnesium can also be taken care of by the use of dolomitic (high magnesium) limestone. Magnesium deficiencies are not likely to occur except on acid sandy soils. Sulfur is adequately supplied by most complete fertilizers. Superphosphate (20%) is about one-half gypsum (calcium sulfate) and thus contains about 12% sulfur. High-analysis, lightweight fertilizers are relatively low in both calcium and sulfur since there is no "room" in the formula to include superphosphate. Sulfur deficiencies occur in areas with little industry and few people because considerable sulfur is released into the atmosphere by combustion of coal and by burning waste materials.

Granular or liquid fertilizers may be used for lawn fertilization. This typical operator, who has a completely outfitted rig, combines insect control, weed control, and fertilization to offer customers an attractive, all around lawn service.

Iron deficiences are seen fairly often on turfgrass. Few, if any, soils are actually deficient in iron for grass culture. When iron deficiency is suspected, test soil pH values. If the values are on the high side, frequently the use of an acid-forming nitrogen fertilizer will be all that's needed.

Primary Nutrient Elements

The main reason for fertilization is to supply nitrogen (N), phosphorus (P), and potassium (K). The familiar grades such as 10-6-4 give the percent *by weight* of these nutrients. The actual pounds of nutrients is found by multiplying the total weight by the grade figures, for example: a 50 lb. bag of 10-6-4 fertilizer contains 5 lbs. of nitrogen (N), 3 lbs. of available phosphate (P_2O_5), and 2 lbs. of water-soluble potash (K_2O). For historical reasons, phosphates and potash are expressed as the oxides. Guarantees on the elemental basis are being sponsored by scientific groups. To determine elemental contents multiply P_2O_5 by 0.436 and K_2O by 0.83. In the example; 3.0 x 0.436 = 1.31 lbs. of P, and 2.0 x 0.83 = 1.66 lbs. of K.

High-Analysis Fertilizers

The availability of more concentrated raw materials have permitted higher analysis fertilizers. Labor savings in handling and application and in cost of transportation and storage are the main attributes of these fertilizers. In addition to the gypsum, calcium and trace elements are largely eliminated in the very high-analysis fertilizers. More attention to liming will be needed with their use.

Grass responds tremendously to nitrogen. The normal farm fertilizer induces very rapid growth that is fairly short lived. The sources of nitrogen used include ammonium nitrate (33.5% N), urea (45% N), ammonium sulfate (20.5% N), ammonium phosphates (11 to 21% N) and sodium nitrate (16% N). Nitrogen from these sources is soluble and readily available to plants. If the plants' season's requirements were to be put on at one time, the grass would first be "burned," then very rapid growth would result and finally at the end of the season, growth would be very slow. Ideally these materials would be applied at monthly intervals or less to give the steady growth desired. The alternative solution would be to use materials that became available more slowly so that 1 or 2 applications are needed, and that are not soluble enough so that the grass is "burned" on application. Natural organics (such as Agrinite) do this job very well. Their main drawback is that they are low analysis and expensive to manufacture and ship. Synthetic organics are higher analysis and are increasing in use rapidly. If a synthetic organic nitrogen source is properly balanced with a quickly available nitrogen and these are combined with phosphate and potash into compact granules, we have practically eliminated the problem of "burn" and the necessity for more than 2 or 3 applications for top quality general purpose turf. Both natural and synthetic organic nitrogen sources depend on soil bacteria and fungi to break down the material to make it available to plants. The first year synthetic organics are used, particularly in the South, growth response has been reported as less than expected. It might well be that a year is needed to build up the population of micro-organisms that make this material available.

The growth response to nitrogen is so great that it overshadows response to phosphorus and potassium. Applications of nitrogen is like accelerating a car — you don't go any farther on a tankful of gas, just faster. Almost all soils are naturally deficient in phosphorus and will require liberal phosphate additions at time of grass establishment. With continued liberal fertilization, phosphorus tends to accumulate because it does not leach out of the soil. When grass is being established, a fertilizer high in phosphate is used, such as 6-10-4. Once established, a grade like 10-6-4 is good. For irrigated areas, especially when the clippings are removed and a high level of maintenance is practiced, a grade high in nitrogen and potash is required, such as 12-4-8.

When to Fertilize Turf

Grass should be fertilized just ahead of its natural growing season. In general there are two groups of grasses; cool-season grasses, and warm-season grasses. Cool-season grasses include bluegrass, fescues, bents, ryegrass, and red top. These grasses will grow in very cold soil; in fact, whenever the soil is not frozen. They do not stand prolonged high temperatures and will usually not survive in southern areas except at higher altitudes and in the shade.

From a custom applicator's standpoint there is a decided advantage in the growth habits of cool-season grasses since fertilizer can be applied any time in late winter or early spring. These grasses should not be fertilized heavily during the hot months. If they are overstimulated, food reserves are taken from the roots and they are easy prey to disease and extended droughts. The best time to fertilize cool-season grasses heavily is during the fall. There is proportionally greater root growth compared to top growth during this period than during the spring flush of growth (in the spring the grass is trying to form seed heads). In the fall there is less danger of overstimulation resulting in an outbreak of disease, and the trees do not compete as strongly for water and light. In the mowing management of cool season grasses, it is important to use a high cut (2″-3″) during the summer months.

Warm-season grasses (Bermuda, zoysias, bahia, centipede, carpet, St. Augustine) grow little when air temperature is less than 60° F. and soil temperature is less than 50° F. These grasses should be fertilized when the above conditions are first reached in the spring, and depending on the growth desired, periodically until cool weather comes in the fall.

How Much to Use?

The amount of fertilizer to use depends on a lot of factors and it is impossible to prescribe for all possible conditions. Managers of airports and highway engineers are going to want the minimum growth necessary to control erosion and dust, while a golf course superintendent must keep the greens growing all season. The golf course superintendent will use 10 to 20 times the fertilizer per unit area as the highway engineer and both may be using the right amount.

The most attractive grasses have relatively high fertilizer requirements and will not present a superior appearance unless these requirements are met. Bents, Merion bluegrass, and improved Bermuda varieties should be fed quite heavily. Kentucky bluegrass, red fescues, St. Augustine, zoysia, and common Bermuda are moderate in their fertility requirements. Bahia, centipede, carpet, ryegrass, and tall fescues are useful for low maintenance areas.

In general, southern areas will require more fertilizer than northern areas, particularly on sandy soils where leaching losses are high. Irrigated grass requires more fertilizer than nonirrigated, and grass grown under trees or around ornamentals will require higher amounts. Cool-season grass grown for ordinary lawn purposes in the moderate group should receive 2 to 3 lbs. of nitrogen. Ten lbs. of a 10-6-4 grade in early spring and 10 to 20 lbs. in the early fall will meet these requirements. If only one application is to be made it should be made in the fall. A comparable application rate for southern grasses would be 3-4 lbs. of nitrogen. Applied, for example, at 10 lbs. of a 10-6-4 per 1,000 sq. ft. in early spring, June, July and September.

Fertilizer comes in many physical forms — granules, dusts, slurries, and liquids. Each form has its advantages and disadvantages. Most applicators have found the fine granule to be the most acceptable and easiest to use with the widest range of equipment. Uniformity of application is a must as overlaps and skips ruin the appearance of grass areas. Applicators with spinning fans do a good job around obstructions and feathering of one application strip into the next without streaking.

Meeting Dates

International Shade Tree Conference, Western Chapter, Annual Convention, Star Dust Hotel, Las Vegas, Nev., May 12-15.

Chemical Specialties Manufacturers Assn. Mid-Year Meeting, Drake Hotel, Chicago, Ill., May 20-22.

National Plant Food Institute Annual Conference, Greenbrier Hotel, White Sulphur Springs, W. Va., June 9-12.

3rd Annual Meeting, Fla. Society of Golf Course Superintendents, Jacksonville, June 18-20.

American Society of Landscape Architects Annual Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa., June 23-26.

American Assn. of Nurserymen Annual Convention, Shamrock Hilton Hotel, Texas, July 29-24.