A COMPLETE FERTILITY PROGRAM FOR HEALTHY TURF

Donald V. Waddington
Department of Agronomy, Penn State University
University Park, PA

Sixteen elements are generally designated as essential elements for plant growth. Three of these elements, carbon, C; hydrogen, H; and oxygen, O, are obtained by plants from carbon dioxide in the air and water. The others are taken up from the soil and include nitrogen, N; phosphorus, P; potassium, K; calcium, Ca; magnesium, Mg; sulfur, S; iron, Fe; manganese, Mn; copper, Cu; zinc, Zn; molybdenum, Mo; boron, B; and chlorine, Cl. Of these 13 elements, N, P and K are referred to as the 'fertilizer' or 'primary' elements. Fertilization is most often needed to replenish these three elements. The 'secondary' elements are Ca, Mg, and S. These elements, along with N, P, and K are termed 'macroelements' because they are needed in greater quantities than the microelements Fe, Mn, Cu, Zn, Mo, B and Cl. Another element that may be essential for grasses is silicon, Si.

Nutrient Removal

Nutrient elements can be removed from turfgrass sites by clipping removal, leaching, erosion, water runoff, and gaseous loss. All elements are affected by clipping removal. About 50% of the applied N may be removed in clippings; thus on an area receiving 4 lb N/1000 sq ft, an expected loss of N due to clipping removal would be 2 lb/1000 sq ft. Based on their concentrations in the clippings, other elements would be removed in proportionate amounts. The main element of concern with leaching losses is N. Erosion loss affects all nutrients; however, such losses are not a problem on most established turfgrasses. Runoff normally occurs only during very intense storms, and soluble materials are most affected. Gaseous losses involve N, which may be lost as ammonia (NH_3) in a process called volatilization or as gaseous nitrogen (N_2) and nitrous oxide (N_2O) during the denitrification process in which nitrate (NO_3) is converted to these gaseous forms.

One goal of fertilization is to replenish lost nutrients. Management practices that minimize nutrient losses can reduce fertilizer needs. Fertilization is also used to build up soil fertility levels and to obtain some desired level of turfgass quality.

Assessing Fertilizer Needs

The need for fertilization may be indicated by visual symptoms. Chlorosis is a symptom that may indicate a deficiency of several elements. Under turfgrass conditions, this yellowing is usually associated with N or Fe deficiency. Slow growth may also be an indicator that an element is deficient. Visual systems should be backed up with soil testing or tissue analysis. Soil tests and tissue analyses may indicate low nutrient levels even when symptoms are not seen.

Soil testing is the most commonly used method for assessing fertilizer needs. Turf areas should be tested every 3 to 4 years. More frequent testing is appropriate on sandy soils, which have low nutrient holding capabilities, and on areas where a severe nutritional problem is being corrected through fertilization. Soil testing procedures vary somewhat from lab to lab, so it is best to select a reputable lab that is familiar with turf and soil conditions in your area.

Tissue analyses are run on turfgrass clippings and are most often used for diagnostic purposes rather than as routine testing. When diagnosing turfgrass for the possibility of nutrient problems, it is a good procedure to submit samples from good as well as bad areas so that comparisons of results can be made. This advice applies to both soil and tissue analyses.

Recommendations based on soil and tissue analyses are normally supported by research and the experience of the specialist making the recommendations. Soil test calibration studies provide useful information for developing these recommendations. More research is needed in both the soil and tissue areas. Dr. J. B. Jones of the University of Florida has suggested the following sufficiency ranges for nutrient concentrations in turfgrass. The values are based on general observations and may not be applicable to all turf or every growing condition. Values less than those indicated may indicate a deficiency. The use of samples from "good" and "bad" turf will aid in making the final judgment.

Element	Sufficiency Range	Element	Sufficiency Range
N	2.75-3.50 %	Fe	35-100 ppm
P	0.30-0.55 %	Mn	25-150 ppm
K	1.00-2.50 %	Cu	5-20 ppm
Ca	0.50-1.25 %	Zn	20-55 ppm
Mg	0.20-0.60 %	B	10-60 ppm
S	0.20-0.45 %	Mo	not known
		Cl	not known

Fertilization

As mentioned earlier, fertilization is most often concerned with N, P, and K. Nitrogen is number one in turfgrass fertilization--often to the neglect of the other fertilizer elements. Nitrogen fertilization enahances turf growth, tillering, and color. Its effects are readily observed. Visual responses to P and K fertilization are seldom observed, but this does not lessen their importance for healthy turf. Benefits of P are seen in seedling vigor and rooting. Benefits of K for stress tolerance are well documented. Some research has shown that K applications above that needed for growth may give additional stress tolerance.

If the soil pH is adequate, both Ca and Mg should be sufficient for plant growth. When they are low, liming normally brings them up to sufficient levels. Dolomitic limestone is recommended when Mg is low. Sulfur is seldom deficient in turf areas; however, responses have been noted in some locations.

Only small quantities of microelements are required by turfgrasses. Deficiency symptoms are seldom seen. When they do occur, deficiencies are usually associated with one or more of the following conditions: alkaline soils (pH >7), either native or over-limed; organic soils; leached sandy soils; heavily irrigated areas; and compacted soils (limited root system). In turf situations, most deficiencies have been noted on putting greens.

Conditions on these areas that may contribute to deficiencies are as follows: highly modified soil (sandy soil), heavily irrigated; compacted; shallow roots (due to close mowing as well as compaction); and clipping removal.

The most common micronutrient deficiency observed on turf is that of Fe, and it appears as a pale green or yellow color (chlorosis). This deficiency usually occurs due to the unavailability of Fe rather than the absence of Fe in the soil. Soil conditions favoring Fe deficiency are high soil pH, excessive amounts of P, As, Mn, and Zn in the soil, high soil organic matter, excessive thatch, and calcareous sands used for soil modification. Iron fertilization can be used to correct chlorotic conditions, and in some cases it is used to darken non-chlorotic turf. Some benefits of iron fertilization that have been observed are enhanced root growth, reduced winter desiccation, and darker color with less N fertilization. Color response due to Fe applications lasts from 2 to 8 weeks, with dry weather favoring longer responses. In University of Illinois research, Fe plus 0.5 lb N/1000 sq ft (from urea) gave color response equal to 1.0 lb urea-N/1000 sq ft.

Commonly used descriptions of micronutrient deficiency symptoms on turfgrasses are from solution culture research at the University of Wisconsin. Many of the symptoms have not been identified in the field, although a response (usually in color) may be observed from application of the nutrient in the field. In a Rutgers University study in New Jersey, Kentucky bluegrass had greener color from applications of Fe, Mn, and B, but not Zn. Toxicity from each of these elements was observed at high rates.

Mn deficiency is favored by alkaline soils and extreme leaching of acid soils. Deficiency symptoms are similar to those with Fe (chlorosis; more so on interveinal tissue than on veins, which remain green), but small dead specks also appear on leaves. Responses to Mn fertilization on turfgrasses has been observed in Florida.

Zn deficiency is favored by alkaline soil conditions. Deficiency symptoms include stunted growth, dark leaves and desiccation.

Cu deficiency is favored by alkaline soil and leached sands. Symptoms include bluish discoloration of younger leaf tips, followed by dieback. deficiencies on turfgrasses have been observed on both mineral and organic soils in Florida.

Mo deficiency is expressed by chlorosis of older leaves and has been reported on bentgrass growing on sandy greens in North Carolina.

B deficiency symptoms are poor color and stunted growth, and Cl deficiencies have not been described for turf.

Under most turf situations there is not a need for specific micronutrient fertilization. The amounts taken up by plants are very small in relation to the total amounts normally found in soil. If a micronutrient deficiency is suspected, tissue or soil analyses can be used to substantiate the deficiency. Micronutrients are added to soils as impurities and incidental elements in fertilizers and soil amendments. They may also be added with fungicides or other pesticides.