manganese, and possibly iron, often can substitute for a nitrogen application. Two to three ounces of an iron source such as ferrous sulfate or 1/2 ounce of manganese sulfate (Epsom salt) in 2 to 5 gallons of water applied per 1,000 sq. ft. provides 2 to 3 weeks of desirable dark green color without an undesirable flush of growth. Since plants receive these elements only through foliar absorption, there is a relatively short color response time.

e. Nitrogen Sources

The source of nitrogen used to fertilize golf greens affects the amount applied. Usually, a combination of soluble and insoluble nitrogen sources is recommended to provide uniform grass growth. Ureaformaldehyde (Nitroform), IBDU, and SCU often are used to provide slow-release, residual nitrogen, while a soluble source is used for quicker turf response. During periods of cold weather, IBDU or soluble sources provide the fastest turf response because they are less dependent on microorganisms for nitrogen conversion and release. Other considerations involving nitrogen sources include higher costs for slow-release and natural organic sources than for soluble ones; salinity hazards associated with the use of ammonium nitrate and ammonium sulfate; and acidifying effects of ammonium sulfate and ammonium phosphate. With the exception of slow-release (water-insoluble) materials, single applications of actual nitrogen should not exceed 1 lb per 1,000 sq. ft. Frequent application of small amounts of nitrogen (e.g., 1/2 lb N per 1,000 sq. ft.) is preferred, since this produces a higher quality turf, avoids growth flushes, and minimizes the potential for leaching. Higher rates of slow-release nitrogen (e.g., up to 3 lbs N per 1,000 sq. ft. every 90 days) can be applied without burn. In most cases, a high-quality turfgrass can be maintained for a 90-day period without flushes of growth or drastic changes in color when slow-release nitrogen sources are used. Additionally, slow-release nitrogen sources leach less than soluble ones.

f. Other Elements

Potassium often is called the "health" element; without a relatively available supply of potassium, turfgrasses are more susceptible to environmental and pest stresses. Root growth also is related to potassium availability. Unfortunately, potassium does not readily remain in the turfgrass root zone, especially in greens constructed chiefly with sandy soils. Therefore, potassium should be applied to golf greens nearly as frequently as nitrogen, but at a rate half to equal that of nitrogen.

Soil phosphorus levels tend not to fluctuate as readily as those of nitrogen or potassium. Soil-test results should be used to determine the amount needed for a particular course. Usually, 0 to 4 lbs of phosphorus per 1,000 sq. ft. are needed per year. Phosphorus is generally not very water-soluble; therefore, if it is needed, application should follow aerification to increase efficiency. This allows the material to be placed more directly in the root zone. Cool-season turfgrasses have a greater color response to phosphorus fertilization than warm-season grasses. To take advantage of this, turf to be overseeded should have a yearly application of phosphorus fertilizer during the cool season.

g. Micronutrients

Regular soil and tissue testing is the best way to prevent many nutrient deficiency problems. Iron and manganese are two of the most common micronutrient deficiencies encountered by Florida turf managers. *If excessive or indiscriminate amounts of micronutrients are applied or soil pH is excessively low, however, plant toxicity can occur.* For example, turf is sometimes grown on old vegetable or citrus production fields, many of which were frequently sprayed with fungicides containing copper, zinc, and/or sulfur. Because these residues (with the exception of sulfur) are relatively immobile in soils, they have become toxic to turfgrasses in some cases.