The A B C of Turf Culture

Essential Plant Food Elements and How Plants Feed

By O. J. NOER

IN some respects the plant is a more remarkable mechanism than the animal. Its power to utilize simple chemical compounds and convert them into complex organic food materials is unique. The animal cannot maintain its life processes by the use of simple chemical materials, but lives at the expense of food materials originally manufactured by the plant, consuming these directly, or the flesh of other animals that originally satisfied their food requirements by the consumption of plant materials.

While the plant is a manufacturing establishment capable of producing complex materials, the individual plant units or cells resemble the cells of animals in that they require these manufactured foods for their existence. Thus the plant is a factory capable of producing complex organic food materials to supply the demands of its various parts. An understanding of the mechanism of plant growth is essential, and is the foundation upon which plant feeding is built.

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Editor's Note: For the past four years Mr. Noer has investigated the value of various fertilizers in relation to golf turf at the Soils Department, University of Wisconsin, under a fellowship established by the City of Milwaukee.

Our knowledge regarding essential plant food elements and their utilization in the plant has been accumulated within the last eighty years. Prior to that time erroneous theories existed because they were not properly tested by experiment. The painstaking work of chemists and plant physiologists is responsible for our present information. While many problems still await solution, the broad principles now known are sufficient for practical purposes.

Plant Food Manufactured in Leaf

It is in the leaf that the complex organic food materials are manufactured by the process called photosynthesis. The green color of the leaf is due to the presence of a substance called chlorophyll. In its presence energy rays from the sun convert the raw materials, water and carbon dioxide into a sugar which is water soluble. The sugar is used either for the building of more complex materials, as a source of energy, or is stored for future use. When stored it is generally converted into starch which is insoluble. During photosynthesis oxygen is released as a by-product of the reaction and escapes into the atmosphere.

The raw materials carbon dioxide and water are obtained from different sources. Water is obtained from the soil. It enters the roots and passes up to the leaves through the stems. The atmosphere always contains small quantities of carbon dioxide gas. This enters the leaf through small openings, generally most abundant on the under side of the leaf, and dissolves in the water contained in the leaf.

Since the products of photosynthesis are so essential to the plant, and are produced only in the leaf, sufficient leaf surface must be maintained to insure their production in sufficient amounts. This is most important in the fall when reserves must be built up and stored in the turf roots for use in the spring while new leaves are being formed. Raising the mower blades, but not enough to impair the playing condition of the turf, increases the leaf area and insures increased sugar production. Unless closely cut, vegetatively planted greens develop a decided and objectionable nap, so great care must be exercised in attempting to build up reserves by permitting longer fall growth.

Sometimes all efforts to obtain turf on heavily wooded areas fail. Even varieties of grass supposedly adapted to shade refuse to produce turf. The dense leaf growth in the trees effectively absorbs all the light rays and the leaves of the grass below fail to receive sufficient energy rays to permit the production of much needed food.

Plants Require Oxygen

All forms of life require energy. Without it they are as helpless as the engine without fuel. Combustion of fuel supplies the energy which operates the engine. If oxygen is available plants and animals can release and utilize the energy stored in the products of photosynthesis. The animal obtains oxygen by breathing. This oxygen reacts with the carbonaceous material, sugar, releases energy and resolves the complex material ultimately into the simple substances, water and carbon dioxide, which are exhaled. These are the ultimate products produced when sugar burns. The same type of action takes place in the plant. The aerial portion of the plant can obtain an unlimited supply of oxygen from the atmosphere, but the roots also demand oxygen. This must be obtained from the air existing in the interstices between the soil particles. Most of the beneficial soil bacteria

also require free oxygen. The air capacity of the soil is dependent upon its physical condition. Good turf cannot be expected on tight or water-logged soils, because these fail to provide the roots and bacteria with needed oxygen. Tight soils can be improved by the liberal use of organic matter prior to seeding, and water-logged soils obviously need drainage.

Carbon Cycle in Nature

The cycle of carbon is an example of the remarkable balance provided by nature. It is released as carbon dioxide gas when the living organism obtains energy from complex carbonaceous compounds. Green plants under the influence of light absorb the carbon dioxide gas and again build it into complex substances, releasing oxygen which escapes into the atmosphere. Plants accumulate and store these complex materials, and hence absorb more carbon dioxide gas than is released in their respiratory processes. Animals depend upon plants for their carbonaceous food requirements. During respiration oxygen is taken up and carbon dioxide exhaled, which accumulates unless used by plants. If confined in a closed glass box an animal finally dies. Death occurs when the atmosphere becomes sufficiently polluted with carbon dioxide. In the presence of light a plant placed in this vessel purifies the air. The carbon dioxide is taken up and converted into sugar and oxygen is released. Eventually animal life is again possible. Under natural conditions this constant cycle mantains itself and as a result the atmosphere contains a relative constant though small amount of carbon dioxide. Some of the carbon in our bodies may have been a component part of some plant or animal many thousands of years ago.

Essential Mineral Plant Food Elements

Besides the carbon, hydrogen and oxygen used to build sugar, and obtained from carbon dioxide and water turf grasses, in common with all other plants, require seven other chemical elments to produce normal growth. These are nitrogen, sulphur, phosphorus, potassium, iron, magnesium and calcium.

Nitrogen, sulphur and phosphorus, together with some of the products of photosynthesis are utilized in building proteins, an exceedingly complex group of substances. The proteins are the essential constituent of the living portion of the individual plant cells. The mechanism of their formation is not clearly understood. Apparently organic acids are produced during their formation. The plant uses calcium to neutralize these acids and make them insoluble. The presence of exceedingly small quantities of iron are essential to the formation of the green coloring matter (chlorophyll) in the leaf. If absent, chlorophyll is not produced. Magnesium also appears to be an essential constituent of chlorophyll. It is also found as an essential constituent of complex substances in the seed. Potassium appears to affect production of carbohydrates, sugar, starch and cellulose. The last named is the essential constituent of the cell walls. It gives the plant form and rigidity.

All seven mineral elements are obtained from the soil. While the air contains enormous quantities of elemental nitrogen most plants cannot draw upon this inexhaustible supply. Clovers and other legumes can however utilize atmospheric nitrogen. The encroachment of clover in poor fairways is often due to this fact. The impoverished soil does not supply the grasses with sufficient nitrogen to permit active growth. The clover survives and spreads because it can get needed nitrogen from the air.

The growing turf obtains its supply of essential plant food elements from the soil. Plants can only utilize materials which are dissolved in the soil water. Dissolved materials are capable of passing through the walls of the root and thus enter the plant. The soil water at any one time never contains enough plant food to satisfy the entire demand of the growing turf. Thus the rate at which the soil water is replenished with soluble plant food from the insoluble soil materials distinguishes a fertile from an infertile soil.

Approximate Composition of Turf Grasses

Freshly cut grass clippings lose from 60 to 70 per cent of their weight on drying. Thus they contain from 60 to 70 per cent water and 30 to 40 per cent dry matter.

If the dry grass is burned the ash remaining does not exceed five per cent. The volatile matter consists principally of carbon, hydrogen and oxygen. However, nitrogen and much of the sulphur also escape during burning. The mineral constituents constitute the smallest portion of the plant material and of these nitrogen is present in largest amounts.

Practically all soils contain sufficient amounts of all mineral elements except one or more of the following three, nitrogen, phosphorus and potassium. The sources and uses of these three essential fertilizer elements will be dealt with in succeeding articles.