How Grasses Grow—The Function of Individual Fertilizer Elements—Their Use and Mis-Use

FROM seeding to final maturity, plant growth is a remarkable phenomenon. Every seed contains an embryo plant and a supply of food to start growth. Soon after seeding, germination and growth commence, provided moisture and air are present, and soil temperature is favorable. Water is imbibed first, then appropriate enzymes convert the stored food into soluble compounds which the embryo can utilize. Growth begins with the formation of a rudimentary root; an initial stem and leaf. After that, normal plant functions start.

Perennial grasses build surplus food during late fall, which is stored over winter for use in the spring to initiate new leaf formation. Except for this wise provision of nature, renewed growth year after year would be an impossibility. Hence, during late fall somewhat longer grass is in order to insure adequate food production.

PLANT FOOD SUBSTANCES: Simple substances, such as compounds of nitrogen, phosphorus, potassium, calcium, etc., and even carbon dioxide and water are commonly considered as plant foods. The fact that these are only the raw materials out of which plants elaborate needed food should be kept in mind at all times.

The substances needed in quantity are carbon dioxide, water, oxygen, and suitable compounds of nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur. Of these, nitrogen, phosphorus, and potassium are required in such large amounts that it is often necessary to add one or more to the soil as artificial fertilizers. The others are usually present in the air, in soil, or rain, in sufficient quantities; but occasionally crops respond to additions of calcium, magnesium, and even sulphur.

A second group of substances is needed, but in small amount only. The need for iron has been known for a long time, but recently the NEED for minute quantities of manganese, boron, copper, and zinc has been definitely established. Others may be found essential as this new field is explored further.

In addition, plants contain silicon, aluminum, chlorine, sodium, fluorine, cobalt, nickel, etc. Any of these, which are not absolutely necessary, enter the plant because of their presence in the soil solution as soluble compounds.

THE LEAF AS A SUGAR PRODUCER: Throughout its active life, the leaf is the great synthetic factory of the plant, remarkably efficient and capable. Adequate sugar production in the leaf is the first link in the chain of processes upon which plant life depends. The sugar produced there is transported to all parts of the plant where it serves as energy material; is elaborated into other carbohydrates, such as cellulose, starch, etc.; or is used in the synthesis of fats, proteins, and other essential products.

Water and carbon dioxide are the raw products from which sugar is synthesized. Of themselves, these two raw materials do not react chemically to form sugar. Synthesis depends upon the presence of chlorophyll, the green substance of leaves, and a source of radiant energy, which is obtained from sunlight. The necessity for light can be demonstrated by placing plants in the dark. Synthesis then ceases, so sugar production is a daytime activity.

Brief mention has been made of the need for oxygen. Like mankind, plants breathe and need the oxygen of air for the normal processes associated with respiration. Very often, in waterlogged soil, ultimate death of roots is due to air exclusion.

Plants need other materials beside sugar. These are the substances obtained from the soil. They enter the plant through the feeder roots, by the process called osmosis. For absorption to take place, these nutrients must exist in the soil water as dissolved salts. The important functions of each element are as follows:

NITROGEN: In turf management, nitrogen is the most important element. It is responsible for green color and active growth, so need for nitrogen is easily detected by simple inspection of the turf. Nitrogen-starved grass never spreads to form dense turf. By stimulating grass competition, nitrogen feeding is an important factor in clover and weed control.

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Nitrogen starvation is characterized by stunted growth, and sickly yellow colored leaves. An application of soluble nitrogen produces almost instant improvement in color, and causes rapid growth of leaves. Likewise, a fairly close connection exists between the amount of growth, and the amount of nitrogen available. Up to an optimum point, increased growth is roughly proportional to the supply of nitrogen. Soft, sappy tissues result from excess nitrogen.

Most plants prefer nitrogen in the nitrate form, but some probably assimilate and utilize ammonia compounds. In the plant, nitrogen becomes an important constituent of protein.

PHOSPHORUS: From the turf maintenance standpoint, phosphorus ranks next to nitrogen. Its stimulating action on root development is most important. This is especially noticeable on new seedings and accounts for emphasizing the use of phosphate before seeding.

Phosphates are the most efficient nutrients known, so in fertilizers it is customary to use a phosphate compound. In the plant phosphorus is an essential constituent of protein and is abundant in seed.

POTASSIUM: Of the three commonly used elements, potassium is least important in fine turf production, even though it is emphasized for pastures. Its marked ability to increase clover accounts for this difference. On golf courses, clover is looked upon as an undesirable weed, so the use of potash beyond the minimum requirement of grass should be avoided. In a mixed herbage of clover and grass, clover has less capacity to absorb potassium than grass, so in the absence of abundant potash, clover suffers from grass competition. This effect is strikingly shown on the permanent grass plots at Rothamsted, England, where there is notably less clover on the potassium-starved plots.

In plant metabolism, potassium aids in the formation of carbohydrates, such as sugar, starch, cellulose. It gains entrance into the plant as a chloride, sulphate, or nitrate.

CALCIUM: There is reason to believe that calcium is used to precipitate organic acids formed during protein synthesis. Deficiency often leads to stunting and discoloration of the roots. Additions of calcium usually help plants suffering from abnormal nutrition.

MAGNESIUM is an essential constituent of chlorophyll. This accounts for the chlorotic appearance of magnesium-starved plants, which occasionally occurs in nature. In the Carolinas a chlorosis of tobacco, locally called "Sand Drown", can be corrected by additions of magnesium.

SULPHUR: This element is an essential consituent of protein, and hence needed by all plants. Deficiency is not likely on turf grasses. Besides the sulphur normally contained in ferilizers, some sulphur is brought to the soil dissolved in rainfall.

IRON: Although chlorophyll does not contain iron, it is not produced unless the leaf contains small amounts of iron salt. Leaves of iron deficient plants have a characteristic chlorotic or mottled color.

The terms "complete" or "balanced" are often abused when applied to fertilizers. Because a diversified diet is essential to human well-being, it is argued that plants require balanced feeding also. So far the comparison is strictly true, but the fact that plant roots permeate a medium which may contain an abundance of many of the essential nutrients is ignored. For best growth, fertilizers need contain only soil deficient elements; whereas human diet must be well-balanced to provide all the essentials of life.

As usually used, the term "complete" refers to a fertilizer containing nitrogen, phosphorus, and potassium, yet there are instances where these three elements failed to produce normal growth. "Sand Drown" on tobacco has been mentioned, and unless fertilizer contains magnesium also, satisfactory tobacco is not obtained.

"COMPLETE" FERTILIZER DEFINED: Correctly speaking, a complete fertilizer should be defined as one containing a sufficient quantity of any and all the elements needed to correct soil deficiencies. On this basis, phosphate becomes a complete fertilizer where the soil deficiency is limited to phosphorus.

Even if grass always required a "complete" fertilizer, it is hardly reasonable to expect one specific analysis to prove equally satisfactory on all soils. Admittedly, it is easier to follow the lines of least resistance, apply a "complete" fertilizer and thereby hope to correct soil deficiencies, but it is far more satisfactory and certainly more economical to build fertilizer programs on a sounder foundation, namely, one designed to overcome soil deficiencies, taking into account soil type, previous fertilizer practice, and requirements of the particular crop.

(To be continued)

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