Functions of the Three Plant Food Elements

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THE food of plants comes from three sources, water, air and soil. Those from the water and air are in such abundance that they are always present for the full needs of plants. The mineral elements, or those derived from the soil may be divided into three classes:

First, the non-essential, which, although they are absorbed by plants, are not considered to have a vital function, and has silicon, aluminum, sodium and possibly manganese:

Second, the essential and abundant—in this class are iron, calcium, magnesium and sulphur:

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Third, a class which may be considered critical, including nitrogen, phosphorus, potassium and possibly sulphur.

More recent investigations, however, lead us to believe that manganese and magnesium are deficient in some soils and are performing a more important function than was formerly considered. However, the purpose of this paper is to discuss the functions of the three principal ingredients of plant food; namely, nitrogen, phosphorus and potassium.

The use the plant makes of these elements has been carefully studied by chemists and physiologists for a number of years. The use of plant food by grass does not differ widely from other groups of plants, although little direct investigational work has been carried on along this line—the attention of the agricultural experiment stations in the past dealing largely with field-grown crops.

Plant Cell is Unit of Growth

THE plant cell is the unit of growth. The principle of life in the cell is protoplasm; it is the laboratory in which all the changes, which constitute the changes of the plant, take place. The vital processes of plants—assimilation, translocation, respiration and metabolism, are essentially chemical in character. Protoplasm is made up of complex compounds, which differ from non-living matter; first, in chemical composition; second its power of waste, repair and growth; and third, its reproductive power.

Living matter is constantly undergoing change—the result of the breaking down from its activities and by making good this loss by the manufacture of new protoplasm out of simple food materials. Here is where the elements of plant food play their part. With surplus protoplasm it makes new cells, more tissue and organisms. It produces new masses of living matter contained in the seed or fruit, which when deducted from the parent mass eventually begin a separate existence.

Let us consider the functions of each of these three elements. Nitrogen is a constituent of all proteins, compounds which are found as the active components of all protoplasm. Protein is from the Greek, meaning pre-eminence, or of first importance. The protoplasm of the green portions (leaves) of the plant permits protosynthesis of the carbohydrates, the synthesis of other tissue-building materials and the formation of reserve food substances.

What Nitrogen Does

THEREFORE, nitrogen is of the greatest importance to a plant. It promotes leaf and stem growth and gives the plant a dark green color and vigorous appearance. The lack of nitrogen is shown by pale green or yellowish leaves. Excess nitrogen gives rank growth and retards the ripening process. Excess nitrogen produces a soft plant tissue, due to the weak cell wall, which is in turn subject to plant diseases.

If we turn to field crops, on which most studies have been made with reference to nutrition, we find that wheat and oats, when supplied with heavy applications of nitrogen, have weak stalk growth, which makes the plants subject to lodging and to such diseases as rust and others. Wheat and oats belong to the grass family, although they are annuals. The same results are found with such crops as tobacco. While excess nitrogen produces large plants and abundant leafage, the tissues are not firm and fail to mature properly and the plant is much subject to disease. In the early growth of plants nitrogen is largely in the leaves—later it is transferred to the seed.

Phosphorus Stimulates Root Growth

THE second element, phosphorus, while directly essential to plant growth, the effect is not so visible in the general appearance or color. Available phosphorus in early growth stimulates root development, an important feature of grass growth. It hastens the development of adventitious buds or rootlets on plants that reproduce themselves by tillers, root-stalks or stolons. Most plants send out a secondary set of rootlets after those that have been produced directly with the seed. It is with these secondary rootlets that the phosphoric acid seems to have very active effect.

Farmers well know that wheat, seeded in the fall and fertilized with phosphates, makes a much better root system and is less subject to action of frost during the winter than wheat not so treated. This is evidence that more extensive root system is produced by the phosphates. Phosphorus hastens maturity. In other words, it acts in the opposite way from nitrogen and when applied with nitrogen tends to counteract the effects of over-feeding of nitrogen. Phosphorus is indispensable to plant growth, as it is the essential constituent of the nucleus of the cell. It is said to determine the rate of chemical changes in the cell.

Large amounts of phosphates are taken up by the plant in its early stages of growth. Later it is translocated to the seed or grain, which contains large amounts of phosphorus. Since phosphorus is a constituent of every plant cell, and cells form the tissues of the plant, it must be looked upon as one of the very important elements of plant food. It has been remarked that since grass on the golf course or green is not grown for its seed, then why use phosphorus. It should be kept in mind that phosphates are necessary to the growth of all plants and whether the plant is deprived of the opportunity to produce seed or not, the living tissues (the blade of the grass) must have phosphorus.

Potash Forms Sugars and Starches

IT is generally stated that potash forms the sugars and starch in plants. We know that potatoes, beets and sugar cane require and use large amounts of potash. However, all plants require potassium, as it is needed in the cell sap to effect necessary changes in translocation of plant food. Plumpness and size in tubers and grains are dependent on plenty of available potassium. Potash hungry plants are more subject to disease. This is particularly noted in corn, tobacco and cotton, all of which are subject to particular diseases when the soil does not furnish enough potash.

The fact is well known that in general crops, excess potash retards maturity. This point may be of value in the maintenance and keeping of grass more luxuriant during the season. This is probably due to the fact that potash maintains the tone and vigor of the plant. The scarcity of potash is not shown so markedly in the case of plants, except by rather retarded growth and the tendency to be more susceptible to disease.

Each of the three elements, therefore, plays a special part in the growth of all plant life. While it is true some plants use more of one element than another, nevertheless nitrogen, phosphorus and potassium are found as a constituent of all living plant tissues.

The growing of grass under golf conditions, particularly on greens, presents a problem unlike most in the agricultural field. Until very recently little experimental work bearing directly on the fertilizer practice for greens has been conducted. Of course, for many years the agricultural experiment stations and the U. S. Department of Agriculture have carefully tested out the fertilizer requirements, particularly the functions of the various plant food

elements, nitrogen, phosphorus and potassium in producing the various crops. Under such conditions it is now pretty well known how each of these react in the growing of the crop, and particularly the part they seem to play under various conditions of soil and at various stages of plant growth.

Golf Course Has Artificial Conditions

ON the golf course we have very artificial conditions. The plant cannot be cultivated and on greens it is cut close, perhaps every day in the growing season. It is heavily watered and, to maintain the proper physical condition on the surface, repeated additions of compost and sand are made.

Heavy watering almost daily in hot weather produces a condition of soil tilth or structure that may be favorable or not to the best growth of grass, particularly since this greatly depends on the drainage and aeration of the soil. Therefore, there are no other conditions quite comparable. It is true with pasture environment, where cattle graze regularly, we have a condition more or less similar. However, the trampling action of cattle on grass is far different from the effect of footprints made by human beings. Further, the treading of the grass while the soil is quite wet furnishes another factor that is not at all favorable. These are some of the conditions confronting the greenkeeper.

At the same time the continued clipping of the grass removes plant food and in time the soil is bound to be depleted of one or more elements. The practice in many quarters has been based on the idea that grass needs nitrogen chiefly, if not entirely. This has resulted in repeated applications of nitrogen in the form of sulphate of ammonia or other quickly assimilable nitrogen carriers. This has resulted in forcing the grass, and without question results in a weaker and less resistant turf.

The prevalence of brown patch during the past few seasons seems to be somewhat associated with the practice of excessive applications of nitrogen. While this has not been definitely proved, there is such a close correlation between the practice and the prevalence of this fungus that the relation is hardly to be questioned. Then too, the soil on greens particularly is being constantly modified, due to the additions of sand, compost, etc.

Most Soils Need Phosphorus

MOST soils in the United States are deficient in phosphorus. In other words, under normal field conditions there is not enough available phosphorus to give a full growth to many crops. This should be borne in mind in building greens, that sufficient fertilizer, carrying all three elements of plant food, particularly phosphates and potash, should be applied to the soil before the greens are seeded. The same applies to fairways. The reason for the objection to the use of phosphates and potash in fertilizer often lies in the idea that these ingredients of plant food promote the growth of clover. It is probably true on soils hungry for these elements that clover will come in to some extent. However, the association of clovers with blue grass is one that is constantly changing.

Where land is made suitable to grow clover, blue grass is likely to follow rather than the reverse. The best blue grass lands of Kentucky contain many times as much phosphorus as they do nitrogen and these are almost pure blue grass lands. In other parts of the country, western Virginia, southern Wisconsin and northern Illinois, we find some of the most typical blue grass, but it is noticeable that they are on soils that are rich in phosphates and potash. It is a noticeable fact that stands of legumes, such as sweet clover, alfalfa and even Japanese clover, are followed by blue grass, which tends eventually to crowd them out. The nitrogen gathered by the legumes seems to favor the spreading of the true grasses.

Some of the best stands of blue grass I have ever seen followed, without seeding, fields of alfalfa where the alfalfa was gradually crowded out by the encroachment of the grass.

Recent experiments conducted at the New Jersey Experiment Station, and reported in the December issue of the **National Greenkeeper**, offer some very good evidence along this line. These tests have been running for several years. It was found there that the plats receiving a complete fertilizer showed the least amount of white clover, the most white clover appearing on the check plat. Likewise, tests

with lime, against which considerable prejudice has been aroused in recent years, showed that lime did not increase weeds where ample plant food was added in addition, and it was also noted that lime plus fertilizer gave the best and most uniform growth.

These points are merely brought out to show that perhaps there is not as much danger to be feared from the use of fertilizer carrying phosphates and potash, and perhaps the use of lime, as is generally considered. It is true that bent grass is largely used on greens proper. The bents in their native states grow on soils that have a good supply of potash—blue grass particularly where there are abundant phosphates.

Tests on Pasture Grasses

DURING the past two years The National Fertilizer Association has conducted a large number of tests on top-dressing pasture grasses in various parts of the eastern states and New England. These tests consisted of comparing results secured with the application of phosphates, potash and phosphates, and nitrogen, phosphates and potash. Most of these pastures had been down for years and many of them were on native foundation. It is interesting to note that while the complete fertilizer gave the greatest returns in growth of grass, nevertheless phosphate and potash combined made as much yield as the nitrogen. In other words, phosphates produced 341 pounds, potash 302 pounds and nitrogen alone 650 pounds. Of further interest was the fact that the plat receiving all three elements of plant food maintained a more vigorous growth during the hot summer weather than where single elements were used.

The fact that potash tends to delay maturity when applied in liberal amounts may have some bearing on this point. In these tests it was found that phosphates and potash did increase the amount of clover, but where nitrogen was applied in addition the grass was further stimulated and became a very strong competitor of the clover. Subsequently it may appear that, due to the greater growth of clover, the true grasses will grow more luxuriantly as has been observed elsewhere.

It is worth while remembering that other plants, such as lettuce, spinach and plants grown for their leafy tops are fertilized not only with nitrogen but with large amounts of phosphates and potash also. With grass, we have been trying to keep it growing in many cases by the use of nitrogen alone. Some greenkeepers have found already that they can well afford to apply some complete fertilizer to greens, even during the summer, if applied in very small quantities along with the compost that is usually put on. Of course, this has to be done with care, but where greens seem to be lacking vigor and tone undoubtedly fertilizer carrying phosphates and potash will be of much benefit.

Apply Fertilizers Early in Season

WHERE complete fertilizers are applied it seems from all evidence obtainable at present that it should be applied very early in the growing season, as soon as grass shows signs of renewed growth in the spring. The test conducted by The National Fertilizer Association, referred to above, showed that where the top-dressing was made early that there was twice as much grass produced as where it was applied 30 to 50 days later.

The early application of top-dressing means more vigorous and better turf earlier in the season and a very much better established grass during the late summer. Golf courses that formerly applied fertilizers in the usual manner—after the grass is well established—have found upon changing methods and applying the fertilizer very early that they have received a much more permanent growth of grass.

Much of our knowledge of growing grass is empirical. What we need is some definite experimental work to establish the factors most favorable to growing grass under the very artificial conditions now obtaining on greens and even on fairways. One of the lines of work that might be undertaken is a study of the root system development as effected by the repeated cutting.

Does frequent cutting weaken or tend to strengthen the root system?

Does the heavy watering during the summer keep the feeding roots near the surface or does it cause them to go down?

These factors have a definite relation to the

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Toro's Complete Line

As usual the handsome illustrated catalog of the Toro Mfg. Co., 3042-3160 Snelling Ave., Minneapolis, Minn., carries within its covers photographs and descriptions of its complete list of golf course equipment. The policy of this company is to keep abreast of the times and every year sees something new added to its already extensive line, based upon the experience of the previous season.

The Toro catalog this year displays the new power putting green mower with its light weight, 4-cycle motor and eight-blade cutting reel. It is built in one size only—19¼-inch cut—with full length rollers front and rear to prevent scalping on undulating ground. The material and workmanship is fully up to the Toro standard.

Another new item is the Toro Junior tractor with dump box body, which is equipped with a Ford 1930 Model "A" Heavy Duty engine and gives speeds ranging from four to twenty miles an hour. The wheel base is 98 inches and the total width is 78 inches.

The Toro Junior tractor is an excellent supplementary machine for eighteen hole courses and as an all-around general utility machine for nine hole courses, because it has such a wide range of usefulness. Field tests have proved that the new Toro tractor will climb a 30 per cent grade with a full body load.

The Toro catalog is really worth while and should be in the files of every greenkeeper and Green committee chairman. It will be sent free upon request.

Seeds of Success

Every year brings a new catalog from J. Oliver Johnson, Inc., Morgan-Huron-Superior Streets, Chicago, Ill., under the title, "Seeds of Success". This catalog not only deals with grass seed, but covers a complete line of golf course equipment of every description, as well as fertilizers, top dressings and disease killers.

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permanency of the turf. Further, a histological study of the cell structure of grass should be made under various fertilizer treatments. Do repeated applications of nitrogen weaken or strengthen the cell wall? This information is of value in determining the relation of fertilizer treatment to resistance to disease and attacks of brown patch. I thank you.

High Spots of the Convention—(*From page* 9)

the Annual Convention in token of the remarkable services they have rendered for them. Both Mr. Morley and Mr. Burkhardt were among the original organizers of the Greenkeepers Association at the first meeting held at the Sylvania Country Club, Toledo in September, 1926.

John Morley, president of the Association pronounced the Annual Banquet at Louisville the best ever held by the Association. George Davies, chairman of the Entertainment committee and his associates were highly praised for the efficient work they did not only at the Banquet, but throughout the entire week.

Harry Burkhardt, chairman of the Registration committee reported a considerable increase in attendance over last year's Convention in Buffalo. He sprung an innovation this year by issuing three sets of badges —one for members of the Association, one for Exhibitors and one for Guests.

"Bill" Farnham, sports writer of the Herald Post, Louisville afternoon newspaper who handled the newspaper publicity for the Greenkeepers' Golf Show and Convention has been appointed Publicity representative of the National Association of Greenkeepers of America. The appointment was made by President Morley.

George Davies, the Louisville live wire, sprung a unique surprise on the greenkeepers with his reproduction of a one-shot hole in one of the booths of the Golf Show. It was completely turfed from tee to green with grass which he grew in a greenhouse, had a creek with water in it running across the fairways between the tee and the green, and was dotted with trees and miniature figures to give it a realistic appearance. This unique achievement was one of the high spots of the week.

A Live Wire

By Robert E. Power

THIS is the first picture we have ever seen of "Lew" M. Evans sitting down. Just how the photographer kept him quiet long enough to get this photo is indeed a mystery. For "Lew", let it be known, is a live wire and about the busiest boy in the "Big League" of greenkeepers.

Some months back wise old John Morley made him National Organizer of the National Association of Greenkeepers of America. He had John Quaill buy him some postage stamps and a couple of new pairs of shoes. Since that time Lew has been burning up the trails leading to the lairs of languid greenkeepers. And how he has preached the N. A. G. A. gospel to them is nobody's business.

So here's fair warning, one and all. If Lew Evans gets on your trail you better join up because you will never get a minute's rest until you do. And you will be glad of it some day and will thank Lew for making you do it. Your club will thank you too because golf officials generally are fast becoming convinced that the National Association of Greenkeepers of America is doing more good for golf in a constructive way than any other agency in the world.