NEWS LETTER

Never leave that till tomorrow which you can do today.

—Franklin.

AUGUST

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NEW BULLETIN

A new bulletin of special interest to all growers has been recently issued by the Cornell University Agri. Experiment Station as Memoir 174, "Certain Rarer Elements in Soils and Fertilizers, and their Role in Plant Growth", by R. S. Young. The appended introduction to this bulletin brings to mind several interesting questions.

For many years the remarkable stimulating or depressing effects on plant growth following the application of minute quantities of certain elements have aroused widespread interest. Gradually, as analytical methods became more refined and the purity of nutrient salts could be more accurately determined, it was recognized that additions would have to be made to the list of elements hitherto considered essential for plant growth. These less common elements, such as manganese, boron, copper, and others, are no less indispensable to the life of the plant than the "ten essential elements" of the older plant physiologists. The sole difference between these two classes of nutrients is that those in the latter group, such as nitrogen, phosphorus, and potassium, not only are tolerated but are required in fairly large amounts, whereas only minute quantities of those in the former group are necessary, and a slight excess often gives rise to pronounced toxicity.

It is likely that further research not only will extend the list of essential elements, but also will indicate that a deficiency of some of these less common soil constituents may, under certain conditions, be the limiting factor in crop growth. The addition of salts of copper and manganese as soil amendments has now become an established practice in certain localities where these elements are deficient. It is conceivable that other stimulating compounds may be employed as artificial manures to increase crop yields.

The spectacular rise of the synthetic-fertilizer industry in recent years, and the increasing use of synthetic fertilizers, have raised the question whether such materials, which are presumed to contain few, if any, unusual elements, will prove adequate for crop growth. Some producers and distributors of natural fertilizers are now claiming superiority for these over synthetic products, on the basis of their alleged higher content of unusual elements. Since methods for the determination of these elements in soils, plants, and fertilizers —with the exception of a few such as copper and manganese—are lacking, no experimental data are available to show the amount of these constituents in the above materials. It was considered, therefore, that an investigation might well be undertaken into the occurrence and determination of certain rarer elements in soils and fertilizers, their availability in the soil and effect on the plant, and the maintenance of an adequate supply through the application of ordinary commercial fertilizers.

It should be stated at the outset that the expression "rarer elements" is used in this work to denote many elements which, from the standpoint of geochemistry, are not rare, being widely diffused in small traces in nature. The soil chemist or the plant biochemist, however, designates such elements as copper, chromium, arsenic, and so on, as "rare," since they occur in small amounts, if at all, in materials with which he usually works, and it is only recently that attention has been directed to the role of these in plant or animal nutrition. The term "less common elements" is sometimes used, but this is rather a clumsy expression. It is regrettable that no accurate and convenient designation for these elements has been proposed.

The rarer elements may affect plant growth in a variety of ways. In the first place, an element may be essential for growth and maintenance of life of the plant. The indispensable role of manganese, boron, copper, and zinc for many plants has been repeatedly con-

firmed, and indications are not lacking that many other elements are essential for plant growth. The fact that only minute traces may be required does not lessen the importance of these less common constituents. It is conceivable that under certain soil and climatic conditions even the small amount of these elements necessary for metabolic activities of the organism—for example, cell division—might become the limiting factor for growth. It is logical to assume that each species would require a different minimum quantity of these elements, just as we know, at the other extreme, that plants vary in their tolerance toward certain salts.

Closely linked with this is the partial or perhaps complete replacement of one element by another with no apparent injury to the organism. It has been demonstrated that the function of calcium in the nutrition of certain lower forms of plant life may be nearly, if not completely, performed by strontium. Further research may show that the similarity of elements in the periodic table is paralleled in the effect of the elements on plant growth.

It is possible that some of the hitherto unexplained deleterious effects of one crop on a succeeding crop may be due to the removal of the available supply of one of the less common essential elements, and a resulting temporary deficiency of this in the soil. Sunflowers, for instance, which are rapid-growing plants, are extensive feeders, and have a very high manganese requirement, would be expected to be capable of reducing the quantity of this element under certain conditions until it became limiting for a succeeding crop.

Another possible role of these elements is that of catalysts. Here, while not entering into the structure or the body substance of the plant or organism, they catalyze the vital functions of these, performing the same function as do the less common metals and their compounds in many industrial processes. Many European investigators, notably Bertrand, lay great stress on this catalytic effect. It is possible also that traces of some elements may act as negative catalysts, depressing certain reactions in the living cell. According to Warburg's conception, all biological oxidations in which oxygen is the hydrogen acceptor are conditioned by the presence of iron in the cell. Substances that react with iron, therefore, as arsenious acid or hydrogen sulfide, would inhibit the oxygen uptake of the cell.

An element may influence plant growth by inactivating a toxin in the soil. Toxins may be organic or inorganic. With organic toxins, arising from decomposition of organic matter, crop residues, or the like, in the soil, the addition of a less common element or its compounds may, by a rearrangement of the configuration of the molecule, greatly reduce the toxic action of the organic compound. A good example of the inactivation of an inorganic toxin is the reduction of sodium toxicity by small amounts of copper or zinc. It is probable that further investigations into the antagonism of ions would reveal many important effects of the less common elements on plants.

The addition of metallic compounds to a soil may result in a change of reaction and other far-reaching effects. If, for example, $MnSO_4$ is applied, the cation replaces hydrogen in the soil complex, and this unites with the sulfate ion to form H_2SO_4 increasing the acidity of the soil. The acid thus formed could react with carbonates in the soil to liberate carbon dioxide. This may bring about profound changes in the soil and its accompanying flora. Wilson and Wilson (1933) have shown that such a narrowing of the carbonate phosphate ratio results in an increase in numbers and growth of Azotobacter in peat soils.

One element may aid in keeping other elements in the soil oxidized or reduced to forms more readily available for plants. The effect of manganese in oxidizing iron to the more difficultly soluble ferric form, and the possible role of this element in maintaining the correct ratio of Fe^{++} to Fe^{+++} ions after the reduction of the latter to the ferrous state, are examples of this effect of rarer elements on plants.

An element may liberate another element, lower in the electromotive series, from its compounds and thus change the composition of the soil solution. Whether the liberated element is one that is required by the plant in relatively large quantities, or not, will be the major factor determining the result of this action of one element on another.

In a similar manner, an element may act indirectly on plant growth by precipitating another element in the soil solution. It is possible, for instance,

that sulfur may become limiting in a soil containing a high content of barium.

The presence of certain elements in the soil solution and in the plant may give to the latter a greater resistance to diseases or parasites. A concentration of copper which would be harmless to a plant might be lethal to a lower organism. Several workers have reported that the addition of silicon or radioactive fertilizers gave plants greater resistance to diseases or parasites.

Again, the less common elements may exert a true stimulating effect on plants, comparable to the effect of vitamins on animals. In this case, while the plants can make good growth and even reproduce normally without these elements, or at least with smaller quantities present than can be detected by any means at our disposal at present, the addition of small amounts results in a considerable increase in growth. Following out the analogy with vitamins, the general health of the plant will be greatly improved and its resistance to deficiency diseases increased by these supplementary plant foods.

A striking effect of the addition of some elements to plants is a marked change in external appearance, often without any apparent detrimental effect on the organism. Soil treated with K_2SO_4 produces the ordinary reddish flowers on **Hydrangea hortensis,** while soil treated with $Al_2(SO_4)_3$ produces plants which bear blue flowers.

Some elements have been considered to play an indifferent role in plant growth, being merely absorbed by the plant roots along with essential nutrients. It is rather difficult to conceive of an element playing such a passive part in plant nutrition; while the chemical effect might be negligible, the element would probably enter into the mechanical or the physico-chemical relations of the cell. It has been shown that the addition of an element such as chlorine, apparently "unessential" for certain plants, may improve the properties of a medium which contains the essential elements in improper proportions.

The effect upon plant growth of many salts which do not belong to the group of essential elements can be explained from the standpoint of colloidal chemistry. Potassium ions, for instance, in a pure aqueous solution are so strongly adsorbed that they injure the colloidal condition of the cell. When aluminum is added, neither ion can monopolize the cell surface and the effective concentration of both ions is decreased. The removal of the toxic effect of copper and of iron by aluminum has been demonstrated. The rate of metabolism and the rate of respiration both increase under the influence of ions of the heavy metals. The metallic ions are adsorbed on the protoplasm, and increase thereby its adsorptive power for certain other substances. The toxic action of the heavy metals in greater concentrations is probably due to their denaturation of the plasma colloids. The action of aluminum on the protoplasm is exactly the same as its action on a non-living gel. In low concentrations it precipitates the colloid, in somewhat higher concentrations no precipitation takes place, and in still higher concentrations the colloid is again precipitated.

It has been found possible to replace mercury in the animal body by using an innocuous electrolyte such as sodium chloride. It may be possible similarly to replace a readily adsorbed metal in plants by ions which, while they are only slightly absorbed, are present in such a high concentration as to enable the removal of the injurious metal from the interface, since even a monovalent ion may have a pronounced effect on the colloidal behavior of an ion of higher valence.

Finally, there are a few elements which have been reported as extremely toxic to plants, and, in the lowest concentrations employed, have not been found to exert a stimulating effect. The fact that copper, boron, and zinc were long considered toxic, or at least non-essential, should lead one to accept with caution the "toxic" properties of many of the less common elements. In many cases it is simply a question of obtaining a sufficiently low concentration, to find that many more elements are indispensable, or at least stimulating, to plant growth. It may be postulated that every substance which in a definite concentration will kill protoplasm, in smaller quantities will inhibit development and in still greater dilutions will act as a stimulant. The immediate source of energy for cells is oxidation of elements or compounds which yield energy by this process. Any element, therefore, when viewed from the standpoint of an energy source for plants, may be considered essential.

It should be kept in mind that the addition of some of these rarer ele-

ments to many soils would be useless, since, minute traces only being required, they would probably not be the limiting factor in crop growth. On the other hand, while the soil might contain small quantities of these constituents, the addition of a readily available form might result in a marked increase in crop yield.

The remainder of this bulletin is devoted to a review of existing literature on the subject, an explanation of experimental work done with the occurrence and determination of various less common elements in fertilizers, the effect of the addition of various elements to fertilizers on the growth of crop plants, the effect of various elements on the growth of algae, with summary and conclusion.

R. W. Peckham of Sachuest recently broke the course record there, when he shot a fine 33, including four birdies.

AUGUST MEETING

The August meeting was held on the 12th at the Ponkapoag Golf Club, Canton, Mass. This course is owned and operated by the State under the Metropolitan District Commission, and is both daily fee and also yearly membership in its operation. As this was the first time that the club had met on a fee course, the tournament was of special interest. The winners were:

1st net, Arthur Fontaine, 104-66
2nd net, O. L. Wendell, 90-67
3rd net, Lloyd Stott, 98-68
4th net, Carl Treat, 91-70
5th net, Joseph Johnson, 100-71

We heard recently that the stork had paid two visits to Rhode Island State recently, on the 28th of June to leave Barbara Dare with the Norths, and on July 28th to bring Robert Ira Campbell to Director and Mrs. Gilbert.

A Bulletin issued this year by the Rhode Island Agri. Experiment Station as Contribution No. 469, "The Relative Seed Yields in Different Species and Varieties of Bent Grass", by H. F. A. North and T. E. Odland, gives the results of the experiments conducted at the R. I. Station for the past several years, mention of which has been made in the NEWSLETTER many times previously. The Summary and Conclusions, as given in this bulletin, are as follows:

Summary and Conclusions

The fine bent grasses have been found eminently adapted for putting greens over much of the northern half of the United States. Fine bents have formed beautiful and enduring lawn turf in New England since colonial times, and more recently have been found valuable in a variety of sports turf.

The growing of these grasses for seed has become an important industry in certain sections of this country. Very little investigational work on the problems of bent seed production has been reported. Results of experimental work at the Rhode Island Agricultural Experiment Station on seed production of different species and varieties of bent grass are reported in this paper.

Experiments were begun for the purpose of obtaining an estimate of the yield of seed that might be expected under commercial production and at the same time to discover how closely the seeded turf would resemble the turf from a vegetative planting in a number of strains. Other experiments that have been reported in previous publications concerned fertilizer tests on colonial bent grown for seed and the relative value of the different bents for golf greens.

It has been shown that the turf from seed and the turf from vegetative planting in a strain tend to become very similar in putting quality.

Quadruplicate plats were planted with 12 different bent grasses and satisfactory stands were secured. The species included were **Agrostis alba, A. tenuis, A. palustris,** and **A. canina.** Rather high levels of fertility were maintained. Tabular data on the growth and yield of recleaned seed are presented for the years 1930 to 1934.

Colonial and velvet bents were found to continue relatively free from weeds and mixtures in practically full stands. Although mixing with colonial bent was evident in plats of redtop before lime was applied, the stands continued relatively pure.

Stands of creeping bent were short lived and permitted of invasion by weeds and other bent grasses.

The yield of seed varied widely from year to year and varied also among the grasses. The average yield of seed for the period varied from 58 pounds per acre for B. P. I. 14,276 velvet bent to 213 pounds for redtop. Astoria colonial out-yielded Rhode Island colonial by about 20%. Highland velvet bent yielded about 15% more than Rhode Island colonial.

Based upon the seed yield of redtop, there was a gradual downward trend in the percentage yield of the colonials, a gradual upward trend in velvet bents, and a rapid downward trend in creeping bents.

The experiments indicate that the improved vegetative strains of velvet bent can be successfully grown for seed production, but that the stolon strains of creeping bent are more difficult to grow for this purpose.

The high quality of velvet bent turf for the putting green and lawn may be expected to increase the demand for the seed. Seed of exceptional strains, such as B. P. I. 14,276 and Kernwood, should command a special premium in price.

The annual club championship will be held at our next meeting, on Sept. 9th at the Winchester C. C., Winchester, Mass. It has been several years since we last met at Winchester, and there should be a large attendance to play and examine this fine course.

Among the new features, advertising of which has recently reached our desk, are the Toro Rust Proof Bed Knives, now cadmium plated to give permanent protection against rust and corrosion; and, the new Buel Kultivator, which has fixed spikes instead of the hinged spikes of the well-known Perforator.

LETTER FROM U. S. G. A.

The following paragraphs are from a letter to our club from Mr. Harold W. Pierce, Chairman of the Green Section of the U. S. G. A. This letter was read at the August meeting, but no action was taken at that time. Any thoughts or reactions by our members will be appreciated by your president.

You are doubtless aware that on account of smaller income from championships and the resignation of many member clubs, that the income of our Association has been materially reduced, and therefore it was necessary to curtail funds allotted to our Green Section research work.

The importance of this work is fully realized by our Executive Committee, and therefore at our June meeting the general policy of seeking outside contributions for this work was considered.

It was therefore, voted to try to obtain contributions from sectional golf associations, The Professional Golfers' Association, Golf Club Manufacturers Assoc., National Assoc. of Golf Ball Manufacturers, Power and Gang Lawn Mower Manufacturers Assoc., National Fertilizer Assoc., Seed Trade Association, The National Association of Greenkeepers of America, and other associations and organizations that may be interested in this work.

It was also voted that no subscription should be accepted from any concern that could benefit directly from any tests that we should make to the exclusion of others. The only exception to this ruling would be to accept donations from individuals who feel that they have benefited directly or indirectly from our Green Section research work.

SUGGESTIONS FROM OUR FILES

Fall fertilization on fairways with organic materials has passed the experimental stage. It is now a proven fact that benefits are greater than when applied in the spring.

Excess waterfall and artificial fairway watering systems have proven the need of additional plant food, preferably in the fall. Without this added food, weeds will predominate.

Lack of proper plant food in the soil accounts for more poor lawns, scraggly shrubs and mediocre flowering plants than all other causes combined.

Timeliness—Any program for brown patch control must depend on prevailing weather conditions. Since the disease tends to develop rapidly during warm, humid weather, it is well to shorten the interval between applications during such conditions. In general, applications every two weeks are sufficient to prevent brown patch, but during warm, rainy or humid weather, it is advisable to repeat the applications at weekly intervals.

Feeding turf is as interesting as life itself. In fact, it is life itself, for grass plants are vegetable life just as man is a part of the animal life of our world. It is interesting, too, to note how closely these two types of life are connected. Man must eat foods that will supply bone, tissue and fats or carbohydrates. So must all plant life have foods that will supply tissue or fiber, root developing material just as man must have material for bone building; and just as a salad makes our own meals more palatable, so does Potash make the other food ingredients more readily available to the plants.

Man cannot and does not eat the same foods that a camel, horse or dog live on, nor do the camel, horse or dog thrive best on one food. It must be balanced. This same analogy is applicable to plant life. Roses thrive best on one kind of plant food, corn on another, potatoes (tuberous fruit) on another, and so on, ad infinitum. It is easy to see then why it is so necessary to select plant foods that have been actually found to furnish those materials that really supply nourishment to the kind of plant under discussion whether it be grass, flower, vegetable or shrub.

Again, we find another difference in plant life. We may have a rose garden or an old fashioned garden filled with a profuse variety of flowers that will afford bloom all through the summer and fall. Each flower has its place and time of blooming and then becomes dormant until the next season, and we

feed these plants to produce the finest blooms. It is quite different with grass or turf for it is expected to remain in its prime all through the season from early spring until late fall without the rest period which the flowers receive. It is true that some grasses are at their best at different times of the season, but generally they must all "hold up". Why then try to use the same forcing methods that are used on flowers? Would it not be better to supply the sod with a sufficient amount of properly blended **food** that is known to be **best for grass plants** and so blended that it will gradually become available to the plants so that they can use it up completely?

"Low Maintenance for Fairway Mowers"

A new departure in Fairway Mower Maintenance is brought to our attentiin by the announcement of the Power Lawn Mower Service Company of Somerville that their National Mowers are bonded with an Eight Year Maintenance Agreement between the factory and the purchaser.

You can send the Heavy Duty Nationals to the factory at the end of eight years, or at any time previous, and the factory will rebuild them, replace all worn or broken parts, all cutting blades, repaint, sharpen, and make practically like new, at a price not to exceed $15.00 per unit.

A letter from Everett Pyle, now of Goodwin Park, Hartford, Conn., brings news of the No. 14276 Velvet, reported in the last NEWSLETTER as purchased from Frank Robinson. Everett writes that this has been planted in a nursery which covers 2¼ acres, and that he believes that this may be the largest area of this strain planted anywhere. He also reports the birth of Junior Pyle in June, and that his new address is now 400 Campfield Ave., Hartford.

The July meeting of the Rhode Island Greenkeepers Association was held on the 29th with Tom Galvin at the Rhode Island Country Club. The annual clambake was held on August 19th at the Montaup Country Club, Portsmouth.

F. H. Woodruff & Sons of Milford, Conn. have recently issued the second bulletin concerning their grass plots at Milford. This bulletin covers the work during 1934 and spring readings of 1935. Some very interesting information may be obtained from this bulletin, which may be obtained free from the company.

A new book on club management is "Club Economies, Suggestions for Membership Clubs and How to Operate within the Budget", by Archie F. Reeve. This book may be secured from the Cleveland Publishing Co., 90 Broad St., New York City, at $3.00 delivered.

Why, these balls bound.
All's Well That Ends Well.

Put up your iron.
Twelfth Night.

Swearing till my very roof was dry.
The Merchant of Venice.

I'll see what hole is here.
Titus Andronicus.

He is not so big as the end of his club.
Love's Labour Lost.

In your bad strokes, Brutus, you give good woods.
Julius Caesar.