pressure so high as to expel the liquid from the pipette prematurely. In the new pipette the heat of the hand can have no effect whatever as the upper end is open. It is obvious, also, that a pipette of the new type may be easily cleaned. It should be stated that the bend at the upper end, though neither necessary nor given originally, was later added to make it possible either to hang it up or lay it on the table without involving any contamination of either its tip or of the table, for the bent portion is just long enough to make the tip incline downward, but not long enough to cause it to touch the table.

Inasmuch as pipettes of this new type have already found a place in three departments here it is thought to be of sufficient general use to justify passing the idea on to others.

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SPECIAL ARTICLES

EXCESSIVE TAX ON SOIL FERTILITY BY CROP PRODUCTION ON POOR LAND

"UNTO him that hath shall be given—from him that hath not shall be taken away even that which he hath." The above verse of Scripture finds further verification in the larger amounts of certain essential nutrients exacted from the soil by some plants, among them such important cereals as wheat and barley, per unit weight of mature crop grown on poor land than if grown on rich soil. That a soil markedly deficient in available phosphorus or nitrogen must supply more of these elements for the production of a unit weight of wheat or barley grain than is required from a soil fairly rich but not oversupplied with these elements lies in the relationship which the supply and absorption of given quantities of essential elements at various growth periods of the plant have to yield.

It appears from the standpoint of plant nutrition that the conditions which determine crop production can be reduced to three general considerations or factors. They are: (1) the minimum requirement (quantity) of each essential element needed to produce a unit quantity (weight) of mature plant and of its differentiated products, for example, in cereals —grain, straw and roots; (2) the time required for the soil (or other growth medium) to supply given amounts of each essential element and for it to be absorbed by the plant at given growth stages; (3) the length of time required for a given quantity of each essential element after it is absorbed to function to completion in the processes for which it is required and to attain the minimum percentage in the mature plant product of which it becomes a part.

The values of each of these three factors are different with the elements concerned. For example, the amount of phosphorus required to produce a given quantity of wheat grain is different (smaller) than that of nitrogen. The time required for a soil to provide a given unit quantity of available phosphorus to wheat plants is much longer (except in rare cases) than that required for nitrogen. The time required for a unit quantity of phosphorus, after it is absorbed by the wheat plants, to function to completion, that is, for the plant to increase in weight until the quantity becomes the limiting factor to growth, is much longer than that for nitrogen. The values of each of the above three factors are different among plant species; they also vary among varieties of any given species.

The time required for a poor soil to supply plants, for instance, wheat, with a given quantity of a given plant food—phosphorus, for instance—is different (longer) than it is in the case of a soil that is fertile as to this element. This difference projects the time when equal quantities are absorbed by plants grown on such different soils much later in the growth development of the plants grown on the poor soil than in the case of those grown on a rich soil. But as the total growth period of many plants is largely fixed by their genetic constitution—although the actual growth period varies more or less with soils and climatic conditions—it follows that the developmental stage obtained when equal quantities of an element are absorbed by plants grown on such different soils would be much nearer to the period of maturation for those grown on poor soils than those grown on the rich soils. As a specified yield requires a quantity of each essential element, which can not be less than that indicated by the product of the weight of the mature plant times the minimum percentage of such element in the product, it follows that the time required for a plant to absorb that quantity when grown on a poor soil would much more restrict the time remaining for utilization of that material than would be the case if the plant was grown on a rich soil.

The maximum utilization, or growth, or increase in weight—whatever term is desired to express the phenomenon of the additions to the weight of a plant by the absorption of elements subsequently to the time a specified quantity of a given element was contained in the plant—is obtained when the given specified quantity enters the rôle of a limiting factor. The element attains its minimum percentage when the maximum amount of other elements have been combined with it,

or have otherwise been incorporated into the plant. As a time interval was required for the given quantity to be absorbed, so a time interval will be required for other elements to combine with it or become a part of the plant. But the quantity of other elements that will be added to the weight of the growing plant subsequent to the time the specific quantity of the given element is absorbed is conditioned by similar factors as those which affected the intake of the specified quantity in question—namely, the character of the soil and the climate together with that of the time available for the processes to proceed.

The genetic constitution of the organism brings on the termination of growth in due time regardless of how favorable other conditions may be. If one plant process is contingent on another and both stand together reciprocally in their relation to the whole organism, variation in one must have a corresponding reaction in the other. It is the contingent and in a measure reciprocal relation of the two processes—(*a*) the time required for a plant to absorb a given quantity of an element, (*b*) the time required wholly to utilize the quantity absorbed—that sets the condition whereby a soil deficient in an essential element like phosphorus is required to supply a larger amount of this element per unit weight of mature plant than is required from a soil well supplied with this element. That is, the longer the time required for the plant to absorb a given quantity, the shorter the time remaining for it to utilize it. If the quantity absorbed is too large or the time required to absorb any given quantity is too long in relation to the time required for complete utilization, the result of such a condition is that a higher percentage of the element will be found in various parts of the mature plant. The yield (weight) of plant that was obtained would also have been obtained by a smaller quantity of the element if absorbed at an earlier growth stage.

The relation of yield to the composition of a crop such as wheat or barley grown on poor soil as compared to that grown on a fertile soil has similarity to the relation between yield and composition expressed in the "Mitscherlich law" but obtained under diametrically different conditions. The relation cited in the latter case ("Mitscherlich law") of decreasing increments of yield with increasing increments of factor (the element deficient in the poor soil) supplied and absorbed by the plant is due to the fact that the time required for such increasing amounts to be absorbed projects the period when this is attained correspondingly closer to the period of maturation, and the time thus remaining for growth after the quantity is absorbed is too short to permit of its complete utilization—hence the high percentage of the element in various parts of the plant. The relatively high percentage of the element in the crop grown on a poor soil is due to the fact that the soil could not supply sufficient amount of the element in the early growth stage of the plant to effect the requisite vegetative development required for a large crop, and the largest part of the quantity which the plant did contain at the end of growth was absorbed too late to be effective. Cause for the relatively high percentage of phosphorus or nitrogen that is frequently found in wheat or barley grown under the conditions mentioned—a soil poor in one of these elements as compared with the soil fertilized with one of the elements—is thus due to the same factor: insufficient time for utilization after the given quantity is absorbed.

The relations above stated, however, do not hold for plants that are markedly less differentiated than are wheat and barley as to the requirements of the final products—grain, straw, roots.

A more complete account of the experiments will appear elsewhere.

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COMPARATIVE RACIAL DIFFERENCES IN COLOR-BLINDNESS[1]

CONGENITAL color-blindness occurs in three chief forms: the common form in which there is confusion between red and green; a rare form known as total color-blindness in which all colors are confused, and a very rare type in which blue is confused with yellow. Red-green blindness appears to be a sex-linked Mendelian character and occurs much more frequently in males than in females.

Interest in possible racial differences in congenital forms of color-blindness was first aroused by Gladstone in 1858, and much scattered work on the subject has been done since that time. Holmgren's wool test has been used most extensively, but this test as well as all those dependent on matching pigment hues is unsatisfactory. Recent work has shown that the wools probably detect only about half of the cases of true color-blindness. Of late years, tests have been made using figures on pseudo-isochromatic cards. Most of these tests consist of a series of plates on which a colored number is presented against a colored background, the diagnosis being made by the manner in which the subject reads the numbers. The best-known tests of this type are those of Stilling and Ishihara. Von Planta[2] compared results obtained by

[1] More complete details of this work together with a summary and comparison of studies by earlier investigators will appear in an early article.

[2] P. von Planta, "Die Häufigkeit der angeborenen Farbensinnstörungen bei Knaben und Mädchen und ihre Feststellung durch die üblichen klinischen Proben," *Graefe's Archiv für Ophthalmologie*, 120: 253–281, 1928.