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.

several of these tests with those given by the anomaloscope and concluded that the series devised by Ishihara was the most satisfactory.

I recently used this test to investigate the incidence of color-blindness among American Indians of the Southwest as well as in a group of Negroes in New Haven. The results obtained are set forth below in comparison with those published on Europeans by von Planta[2] in Germany, and on white Americans by Miles[3] at Stanford University and Haupt[4] at Baltimore. The figures in the table are based on the Ishihara test and refer only to males.

COMPARATIVE TABLE

Race	Investigator	Number tested	Frequency of color-blindness	Percentage
White (Europeans and Americans)	von Planta	2,000	159	7.95
	Miles	1,286	106	8.2
	Haupt	448	35	7.8
American Indians	Clements	624	12	1.9
American Negroes	Clements	325	12	3.7

The percentages of color-blindness among the three widely separated groups of white males closely approximate each other. Taking the three groups together, the actual percentage of the defect among the 3,734 individuals tested amounts to 8.04 per cent. One case in Miles's group was totally color-blind, but all the rest were red-green blind.

Of the 624 Indian males tested, 392 were full bloods, among whom were found eight cases or 2.0 per cent. of red-green blindness. Of these eight cases, six qualified as completely green-blind according to the test while the other two were red-blind. Among the 232 mixed bloods, three cases or 1.2 per cent. of red-green blindness occurred. Two of these were completely green-blind and one was red-blind. In addition, one case of total color-blindness was discovered in the mixed blood group. This case exhibited concomitant symptoms of poor central vision, marked photophobia and nystagmus. A group of 202 Indian females was also tested, but no case of color-blindness was found.

Of the 323 Negro males tested, 205 were probably full bloods. Seven cases or 3.4 per cent. of red-green blindness appeared. Five of these cases were complete green-blinds and the other two were red-blind. Among the 118 obviously mixed blood Negroes were five cases or 4.2 per cent. of red-green blindness, four cases being green-blind and one red-blind.

Miles states that the proportion of green-blindness to red-blindness in the group he tested was approximately 3 to 1. This ratio holds for the group of von Planta where the percentage of green-blindness was 5.75 and that of red-blindness 2.2. In my own results, 2.7 per cent. of the Negroes were green-blind and 0.92 per cent. were red-blind. In the total group of Indians, 1.2 per cent. were green-blind while 0.48 showed red-blindness. Apparently the approximate proportion of 3 to 1 for these two types of color-blindness holds for each of the three racial groups.

The above results seem to indicate that racial differences in color-blindness do exist. In the case of the white groups, the nature of the sampling and the large number of individuals indicates that the incidence of the defect for white males may be rather confidently set at about 8 per cent. The Indian testees were drawn from several different tribes and probably constitute a fairly representative sample. While tests on a larger group might give an incidence somewhat different from that stated here, there can be little doubt that the frequency of color-blindness among Indians is much less than among Caucasians. The Negro sample is too small to do more than indicate the probability that the incidence of color-blindness among Negroes falls somewhere between that for Caucasians and Indians.

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[3] W. Miles, "One Hundred Cases of Color-blindness Detected with the Ishihara Test," *Journal of General Psychology*, 2: 535–543, 1929.

[4] Quoted by Miles, *op. cit.*, p. 538.

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