some success in our upland, acid soils, and millet will now be tried. The effects of acidity upon the crucifers and certain legumes, have been noted in soils notably less sour than most of the upland soils of these islands. The Director and Agriculturalist of the Rhode Island (U. S.) Experiment Station, Professor Flagg, in a communication concerning a sample of soil sent to the laboratories of the writer, says: "We found all this soil acid when tested with litmus paper; so much so that timothy and clover, barley, beets, spinach, lettuce, and a few other plants, failed to thrive without the use of air-slaked lime to correct the acidity."

These observations, which are only a part of extensive investigations that will be published shortly, show the extreme difference in degree of sensibility of the various agricultural plants to soil acidity. They also indicate with what ease a failure in growth of one plant can be attributed to some trouble in plant nutrition, when it may be wholly due to the inability of the plant to bear the acidity of the soil, which is illustrated, as has been shown, by the power of other plants to thrive in the same medium.

METHODS AND SOLVENTS FOR ESTIMATING THE ELEMENTS OF PLANT FOOD PROBABLY AVAILABLE IN SOILS.

BY WALTER MAXWELL.

Received November 23, 1897.

IN framing a method, and in the selection of solvents for estimating the proportion of plant food probably available in soils, it appears necessary to be wholly guided by a precise observance of the agencies by means of which the insoluble soil-materials are being daily changed by the processes of nature in the field, into forms in which they can be used by growing plants.

The processes by which the food elements are prepared in nature are altogether chemico-physiological; and for this reason the problem cannot be primarily considered from an analytical standpoint.

The solvent agents operating in nature's processes are, in addition to water, the acids moving in the sap of living organisms, and being emitted through the membranes of their roots, the chief one, so far as our present knowledge goes, being carbonic acid; and, more important, the acids which result from the decay of vegetable matter upon and within the soil. The acids that are formed when plants, roots, and fruits decay are the simple organic acids,—carbon acids; and the amido acids,—carbo-nitrogen acids. Consequently, the acids in living, and produced by dying, plant organisms are carbon acids, with or without nitrogen. In the complete decay of vegetable matter, however, these organic acids are resolved into ultimate mineral bodies; the carbon into carbonic acid, and the nitrogen of the amido acids into nitric acid or nitrogen, the simple forms in which these were primarily taken from the air to build up the plant organism. Consequently, the amounts of carbon and of nitrogen contained in the composition of plant organisms are respectively the measure of the relative amounts of simple carbon acids and of amido acids that can be produced in vegetable decay; and of the amounts of carbonic acid and nitric acid that finally result from that decay, and which act as solvent agents upon the soil. The minute amount of sulphuric acid, and the still more minute portion of phosphoric acid, that are formed from the sulphur in the nucleins, and the phosphorus in the phosphoglycerides (lecithines), are unnoticed in these considerations. Also the basic action of the amidogen group (NH_2) contained in the amido acids, which has been indicated in our investigations, is reserved for notice until a statement of results in detail is made. In the absence of elementary determinations of carbon in the composite structure of plants, these estimations having been confined to constituent bodies some other mode has to be used for arriving at an estimation of the proportion of that element contained in plant organisms; and, at the same time, of the relative proportion of nitrogen. This is done by ascertaining the amount of the constituents of plant organisms that are composed of carbonaceous bodies not containing nitrogen, and the proportion of these bodies that do contain nitrogen. The carbonaceous bodies free from nitrogen are the so-called nitrogen-free extract matters, the fiber, and, for the present purpose, are added the fats. The bodies containing nitrogen are collectively considered as proteids. The relative amounts of these nonnitrogenous and nitrogenous constituents found in a broadly representative series of agricultural growths are set forth in the following table:

Kinds of growths.	No. of examples.	Proteids.	Fiber.	Nitrogen-free extract matter.	Fats.
		Per cent.	Per cent.	Per cent.	Per cent.
1 Legumes and cereals	32	8.0	27.6	51.0	3.1
2 Roots and bulbs	14	13.9	10.5	64.5	3.1
3 Grain and other seeds	45	12.9	2.3	79.5	4.4
Means	91	11.6	13.5	65.2	3.5

If the third series (the seeds) should not be included in the average, for the reason that the grain and seeds are not allowed to return directly to the soil, the means will remain nearly the same, since the large proportion of the extract matters in seeds is offset by the small amount of fiber. These data show that in the 91 examples of vegetable growths we have:

	Per cent.
Nitrogen-free carbonaceous bodies	92.2
Nitrogenous carbonaceous bodies	11.6

The nitrogen-free carbonaceous bodies, including the small amount of fats, may be considered as bodies containing six atoms or parts of carbon ($C_6H_{10}O_5$). The proteids, in which the elementary analysis finds sixteen per cent. of nitrogen, with fifty-four per cent. of carbon, are bodies in which, according to the relative atomic weights, about three parts of carbon are associated with one part of nitrogen. The relation of the carbon and nitrogen present in those organisms, then, may be expressed thus:

			Parts of carbon.
Nitrogen-free carbonaceous bodies	82.2 per cent.	× 60 =	493.2
Nitrogenous carbonaceous bodies	11.6 "	× 3 =	34.8
			528.0
			Parts of nitrogen.
Nitrogenous carbonaceous bodies	11.6 "	× 1 =	11.6

These data show that in the composition of the plants, roots, and seeds stated there are forty-five parts of carbon to one part of nitrogen. Therefore, in the decomposition of those organisms there must finally be produced forty-five parts of carbon dioxide and one part of nitric acid.

Nitric acid is a more immediately active solvent than carbonic acid, and will dissolve soil material rapidly while its action lasts. The duration and measure of its action, however, are fixed by the quantity, and can extend only to the point of neutralization with the bases it acts upon, which is the case with the carbonic acid. Moreover, nitric acid is a monatomic acid, whilst carbonic acid is a diatomic acid ; which thus doubles the solvent power of the forty-five parts of carbon, and lowers the possible action of the one part of nitric acid to only $\frac{1}{90}$ part of that of carbonic acid, providing both acids exercise their action on the soil bases to neutralization.

These considerations have appeared to the writer to constitute the nature of any method, and the character of any solvent whose action can approximately compare with the processes operating in the field. Their reasonable nature has been amply endorsed in a course of work in which methods were adopted, from which mineral acids were excluded, and simple carbon acids and amido acids were exclusively used as solvents. The results, which form only a part of a broad investigation which is being carried on of Hawaiian soils, and which have been obtained with the aid of the associated labors of our first assistant chemist, J. T. Crawley, and C. F. Eckart, second assistant chemist, will be published in later issues of this Journal.

LABORATORY OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

A DELICATE TEST FOR THE DETECTION OF A YELLOW AZO DYE USED FOR THE ARTIFICIAL COLORING OF FATS, ETC.[1]

BY JOSEPH F. GEISLER.

Received January 5, 1898.

THE food laws of several of the states prohibit the use of coloring-matter in oleomargarine, and inasmuch as the presence of artificial coloring-matter in many cases constitutes the only infraction of these particular laws, simple tests for its detection are desirable. Those engaged in clarifying and decolorizing oils and fats are no doubt familiar with the use of Fuller's earth as a precipitant of coloring-matter, the latter usually being precipitated without any pronounced color reaction. Since text-books and the chemical literature, to my knowledge, do not mention the red to pink color which Ful-

---

[1] Read at the Washington Meeting.