The Gem State Rural

A Monthly Magazine for Idaho Farms and Farmers

Vol. XIV | Caldwell, Idaho, December, 1908. | No. 6

Soils From a Chemical Standpoint.

IV.

FERTILITY.

By Prof. J. Shirley Jones, Chemist, University of Idaho Agricultural Experiment Station.

It is intended in this article to discuss briefly the subject of the soil's fertility, and the most feasible and practical methods of arriving at proper conclusions regarding it.

What is this soil good for; what crops will grow best upon it; how should it be cultivated in order to get the best results from it? These are typical questions often asked of the Experiment Station workers. There is apparently a feeling prevalent among farmers that from the results of a chemical analysis, information should be gained as to exactly what kind of crops are best suited to the soil in question; for the question is sometimes put point blank—Is this soil better for apples than for small fruit, or is it better for grain than either. It is not strange that this feeling has gained prevalence among farmers; for the early investigators in this line of work rather encouraged it, and actually expected to be able from the results of their analyses to answer such questions satisfactorily. It should be said now though, that this is too much to expect of purely chemical soil analyses. Valuable as they are, they can be made to answer such inquiries only in a general way. The farmer may be told how much plant food there is in his soil; but unfortunately he cannot be told as yet, with any great degree of accuracy just how much of it is available at any one time for a growing crop's normal demands. This is not saying that the solution of such problems has been despaired of, for it has not. The soil is being made the subject of careful investigation just now and much may be expected from it in the way of practical working results in the future.

Broadly speaking the chemical composition of a soil will probably continue to be the foundation upon which other investigations relative to its fertility will have to be based. Other considerations than chemical composition, however, must always be taken into account in speaking of a soil's value for crop producing purposes and these will be mentioned further on. Just here, methods of making soil analyses, and interpretation of results will be discussed.

question to a depth of 12 to 15 inches, or to the subsoil if that comes closer to the surface than twelve inches. Usually it is best to take several small samples from as many different spots and mix them all together, obtaining in this way, a mixture from which a composite sample may be taken for analysis. A composite sample of the subsoil or underlying soil should also be taken from the same places. Note should be taken of the amount of gravel or stones, sticks and other debris present. Only the fine soil, that which passes through a sieve whose holes are .5 millimeters in diameter is used for analysis. Mineral plant food is usually thought of as existing in the soil in three degrees of solubility, and therefore it is certainly not all equally available at any one time. There is that part which is soluble in water and weak acids, constituting the portion that is always available or ready for use by the growing plants; that part which is soluble only in quite strong acids; and that part which is insoluble in strong acids, but which may be decomposed by the aid of high heat and a flux of some kind. The nature of the solvent used in analysis will therefore depend entirely upon the object in view.

If only the immediately available plant food is to be determined, then weak organic, or mineral acid is used, while strong acid is employed if the maximum amount of mineral matter that may be reckoned as plant food is to be determined. Of course the water, and weak acid soluble material represents the most valuable of the soil's constituent minerals, it is made up of the easily decomposable silicates, potash, lime, phosphoric acid, etc. It is, except in alkali regions, always small in amount, and usually is not considered sufficient alone to support a normal plant growth. The stronger acid solution will contain, in addition to the above, the more difficultly soluble silicates, the minerals that were in combination with the humates, and the more difficultly soluble compounds of lime and phosphoric acid. In many soils not over 15 to 20 per cent. of the fine earth is soluble in strong hydrochloric acid, (sp. gr. 1.115), and the sum of the really essential compounds, nitrates, lime, potash, and phosphoric acid, is much less than this, say 2 to 3 per cent. So that in most soils every 100 pounds contains, at least as far as plant food is concerned, 97 to 98 pounds of inert material. This statement, of course, must not be taken as meaning that 97 to 98 per cent. of a soil is useless; for it is to be remembered that this constitutes the reserve portion of the soil or the part that will in the future, if it is cultivated properly, provide the soluble portion, and which of course is always of great importance from physical considerations. Thus it would seem that the problem of maintaining his soil's fertility, in so far as the mineral portion is concerned, [illegible] with the farther decomposition of this inert matter.

Below is given a table showing the results of the chemical analysis of three soils. No. 1 is a surface soil taken from the Sub-station at Caldwell. No. 2 is a soil taken near Star, Idaho, and No. 3 is a soil representing an irrigated tract near Hayden Lake, Idaho. The analyses were all made on the strong acid solution of the soils and therefore probably represents more than the limit of the solvent power of the plant roots.

	No. 1 per cent.	No. 2 per cent.	No. 3 per cent.
Insoluble Matter	87.40	84.51	71.72
Potash	.82	.52	.30
Soda	.37	.46	.49
Lime	.83	1.09	1.10
Magnesia	.61	.74	.75
Iron	3.24	2.89	2.88
Aluminu	4.08	4.65	7.53
Phosphoric Acid	.05	.04	.28
Volatile Matter	2.76	5.46	12.99
Humus	1.88	1.94	5.73
Total Nitrogen	.....	.19	.24
Nitrogen as Humus	.....	4.88	4.00

It will be noted that soil No. 1 has considerably more potash than has either of the others. And yet is is possible that more of that in No. 3, for instance, is available for immediate use. Generally speaking, however, it would be safe to assume that those soils which have as high a percentage of potash soluble in strong acid as these, are rich enough in the more easily soluble forms of this important compound.

As for the lime content, the total percentages as shown would indicate a sufficiency of this compound provided it existed in the soils as a carbonate. Unfortunately the amount of carbon dioxide present (percentages not shown in the table) in each case is too small for one to assume that the lime is in that form. As it doubtless then exists as a silicate, the assumption that each is lacking in active lime compounds is probably correct. The phosphoric acid in both 1 and 2 is low, too low in fact to be considered sufficient for the needs of a growing crop. No. 3 has an abundance of total phosphoric acid, but that soil is an acid one, and therefore much of its phosphoric acid will be unavailable until something is done to neutralize its acidity. It will doubtless respond to a liberal application of lime, which is a material most commonly used for neutralizing soil acids. Experiments are being conducted with this soil to determine how much lime will have to be used to "sweeten" it. The term volatile matter should not be taken as meaning organic matter alone for it includes also the water that has been held in chemical combination. A clay soil might have a high percentage of volatile matter, but actually be deficient in organic substances. The percentage of humus however, is a measure of the amount of organic material in its most active form. In both 1 and 2 this amount is [illegible]

manures. It is to be remembered here that humus varies much in composition; the richer it is in nitrogen the more fertile will be the soil containing it. The percentage of nitrogen in the humus was not determined in No. 1 but in No. 2 and 3 it was found to be 4.88 per cent. and 4.00 per cent. respectively. This is low and indicates either that the humous in each case has been exhausted of its nitrogen or that it was formed from organic material not rich in nitrogen.

In the case of Nos. 1 and 2 it is not known what has been the origin of the humus now in them, but No. 3 seems to have derived its stock of this important ingredient largely from that class of plants which possess but little nitrogen. Sorrel, and a similar growth of vegetation, is characteristic of the tract from which that soil was obtained. The important fact is this; Nos. 1 and 2 need more humus, and No. 3 needs humus of a better quality; and this emphasizes the point made in a previous article that when an effort is made to increase the stock of humus in a soil, care should be exercised in seeing that it shall be humus of the best possible quality. It requires no more time to spread and plow under a good grade of manure than it does a poor one; to plow under a growth of peas or other nitrogen gathering crop, than one which does not gather nitrogen, and the better grade of either fertilizer used increases the potential fertility of the land far more than does the poorer one.

A few words now regarding other considerations than its chemical composition, which should always be taken into account when the fertility of a soil is under discussion. One soil sent in recently for chemical examination was found by mechanical separation to consist of 65 per cent. small rocks and pebbles, and 35 per cent. fine earth. Since it was known that the sample was taken correctly, the fine earth was analyzed and found to be very good in so far as the compounds necessary for plant nutrition are concerned. The experienced farmer would reflect at once, however, that in this soil, even though the small rocks would offer no serious hinderance to cultivation, the sum total of plant food which growing crops could draw upon in that soil would be relatively small when compared to an equally rich fine earth not diluted, so to speak, with so large a percentage of material not yet even reduced to rock powder.

On the other hand he should recognize the fact that these same rocks and pebbles (they are too large to be properly described as gravel) will always keep that soil open and porous, thus insuring good drainage, which is an important consideration in irrigated sections. Again, instances are quite frequent, when a fairly rich, fine earth is so shallow that the section in question should not be considered a fertile one. The underlying strata may be rock, an impervious clay, or a hard-pan of such nature that plant roots cannot penetrate it in [illegible]