Soil Nitrogen.

THE element nitrogen plays such an important part in plant growth, and is so liable to waste through careless cultivation, that too much attention cannot be given to study of the preserving that which is already in the soil, and to the problem of adding to the supply.

Storer estimates that in the surface foot of an ordinary cultivated soil, there are 3700 pounds of nitrogen per acre. Therefore, taking Warington's estimate that a crop of wheat producing 30 bushels of grain per acre, removes 38 pounds of nitrogen per acre, the supply of nitrogen in the soil is more than sufficient to produce 70 such crops. Samples of rich prairie soil have shown more than three times the amount of nitrogen mentioned above, and therefore such soils possess a correspondingly greater degree of fertility.

But Nature is too wise to allow that reckless spendthrift, man, to quickly squander the wealth of the soil. If he were allowed to grow these 70 crops of wheat in succession, no doubt he would do so, but Nature places various obstacles in his way, and saves him from himself. The method in which nature accomplishes this object is not clearly understood in all its details, and to enter into a discussion of the subject would be going outside the limits of this paper.

The main source of soil nitrogen is the organic matter which the soil contains. This organic matter is composed of the partially decayed remains of plants and animals which have, at some time, grown or lived upon the soil. It follows, therefore, that the amount of organic matter (humus) which a soil contains indicates the amount of nitrogen contained by the soil.

But plants cannot feed upon the nitrogen as it exists in these organic compounds. The organic matter must first undergo decay or fermentation, and the complicated organic compounds which it contains, must, by this process, be broken up into much simpler forms before plants can avail themselves of the nitrogen. Just here, a few words regarding the different steps in this breaking up process, may not be out of place.

Everyone who reads must know that fermentation is caused by certain minute forms of plant life, called bacteria or microbes, and that different kinds of bacteria form very different products. Then again, everyone who has had anything to do with farm yard manure is familiar with the smell of ammonia which is produced when the manure ferments (heats) rapidly. Here then, we have the first step in the fermentation, or the breaking up, of organic compounds, viz., the formation of ammonia. One class of bacteria feed upon the organic matter of the soil, and, as a result of this operation, ammonia is formed. If this were all, the ammonia would escape as a gas and be wasted; but another kind of bacteria take hold of the ammonia as it is formed, and when they are through with it, the ammonia has been changed into nitrous acid. But this is not all. A third set of bacteria attack the nitrous acid, and the result of their operations is nitric acid. The nitric acid, as it is formed, unites with different substances in the soil, such as calcium, potassium, etc., forming nitrates of these substances. With this latter step the nitrogen is rendered fit for plant food. Plants take up their nitrogen from the soil in the form of nitrates, and build it up again into the complicated organic compounds first mentioned. Thus the cycle is completed, and when the plant dies and becomes incorporated with the soil, the breaking up process will all occur over again.

The process through which nitrates are formed, is called nitrification, and from what has been said it may be seen that nitrification is of vital importance to plant growth. Nitrification is more or less active in all cultivated soils, the conditions favoring it being, warmth, a certain degree of moisture, and the presence of air. It ceases altogether at 41° F., and is most active at 98° F. With a temperature above 98° F. nitrification becomes less active, and at 113° F. it is barely appreciable.

Then again, while a certain amount of moisture is necessary to nitrification, it is possible to have too much moisture in the soil. An excess of moisture checks nitrification in two ways: first, it lowers the temperature of the soil, and second, it excludes the air. But this is not the only injurious effect of too much moisture. In very wet soils, where the temperature is low and the air is largely excluded, there lives another kind of bacteria. These bacteria break up organic compounds, but, unlike the bacteria previously mentioned, they liberate free nitrogen which escapes into the atmosphere and is practically lost. This last process is called denitrification. A few minutes study of the facts given above, will explain some of the great advantages derived from underdraining.

On a well worked summerfallow nitrification is very active, owing to the high temperature of the soil during the summer, and to the free admission of air which the frequent stirring of the soil occasions. But since no plants are allowed to grow on the fallow to take up the nitrates as they are formed, and since nitrates are very soluble (easily dissolved) in water, there is great danger that a considerable quantity of the nitrates will be washed out of the soil by the summer rains and lost in the drainage water. Thus summer fallowing reduces the amount of organic matter in the soil by causing rapid fermentation and wastes more or less of the soil nitrogen by allowing it to escape in the drainage water. The loss, however, is not so serious in stiff clay soils as it is in soils of more open texture.

It is true that the atmosphere contains small quantities of ammonia, nitrous acid, and nitric acid which are carried to the soil by rains, and that the soil of the fallow is in a particularly favorable condition for absorbing the nitrogen brought to it in this form; but the gain in soil nitrogen from this source is very small, and does not compensate for the loss mentioned in the preceding paragraph.

It seems strange that while nearly four-fifths of the atmosphere is composed of nitrogen, plants may die from the want of this element of plant food, and that fertilizers containing nitrogen are among the most expensive on the market. This is explained by the fact that plants cannot feed upon the free (or uncombined) nitrogen of the atmosphere. As stated before, they feed upon nitrogen in the form of nitrates, and these nitrates are taken from the soil by means of the plant roots. It is claimed by some that plants can assimilate nitrogen in other forms, but, in any case, the greater portion of their nitrogen is obtained as first stated.

But it has been discovered that certain plants will grow successfully upon soils containing very little nitrogen, and actually leave the