Nitrifying Bacteria.

By A. J. Bigney.

Everybody is searching for the wealth of the world. The scientist, however, is the one who usually makes the actual discoveries. He may not reap much of the result himself, but the world is richer and better for his having lived in it.

The past few years has seen much wealth added to Indiana through the labors of her scientific men. New sources of income will be found and new applications made as time passes on.

To the most casual observer it is certainly true that southern Indiana, in particular, has too much abandoned land. Waste fields are to be seen on every hand in many communities, and in some localities most of the land has been turned over to the free action of the elements and to the rabbits. As the population increases this land will be needed. The people are not much concerned now, because there is an abundance of land in the country. If their farms become too poor they will sell out and move into other localities or into other States. The time is coming when there will not be the inducements in other places, so the farmers will be compelled to earn a livelihood on the old farm. Even now it would be less expensive and much more satisfactory, especially to their good ladies, to remain on the old farm and transform their worn-out land into a veritable garden. The Germans are doing this very thing now on the hill lands about some of our rivers. This shows that it can be done when our people are willing to devote themselves to the task and not be too anxious to become rich too quickly and with as little labor as possible. When this waste land is put under a high state of cultivation, it will make the country more beautiful and will thus be an incentive to the agricultural classes. Who does not feel encouraged when travelers compliment a people on their beautiful country?

The Department of Agriculture of our Government is accomplishing wonders in developing new plans for work through their laboratories at Washington and in the experiment stations. The farmers are being stimulated to take an interest in scientific farming and the work is being

made more practical and more interesting and also more popular. When they see that no line of work really needs more knowledge and skill it will be a strong inducement to our young people to think of spending their time in developing our country along agricultural lines.

The great need that may be seen in many parts of southern Indiana is the formation of a proper vegetable mould. This means that there must be a greater amount of proteid substance in it. This further means that nitrogen is the element most needed and the one most difficult to secure. Since about four-fifths of the air is composed of nitrogen it would seem that we should not lack for this substance. This source of wealth had remained hidden for centuries. Not until recently did we learn of the part that the leguminous plants play in this problem. Now we know that this class of plants is the one that can make use of the nitrogen of the air for the manufacture of proteid substances of plants.

Fewer than ten years have elapsed since the noted German scientists Nobbe and Hiltner suggested that pure cultures of soil bacteria might be used to inoculate new soils. German experiments continued to be made, but they were quite unsatisfactory.

In 1901 the Department of Agriculture of the United States began investigations in its laboratory of plant physiology to find an artificial medium in which bacteria would grow and still preserve its power or even to intensify its qualities. Furthermore the bacteria must have the power to penetrate the roots of the plants, because it is impossible to fix nitrogen unless they are stimulated by the activities of the plant itself. The result of this investigation was a liquid culture. This culture is put up in three packages, Nos. 1, 2, and 3. No. 1 consists chiefly of sugar with a little potassium phosphate and magnesium sulphate. No. 2 consists of cotton laden with bacteria. No. 3 contains ammonium phosphate. No. 1 is dissolved in one gallon of water and the bacteria placed in it. This must be kept in a warm place, the temperature of which is between 70 and 80 degrees. At the end of twenty-four hours No. 3 is added and kept twenty-four hours more under similar conditions. The water by this time will be quite milky. Examination with the microscope reveals myriads of bacteria in active state.

The seed is now thoroughly moistened with the water and spread out to dry as quickly as possible. This liquid culture will retain its qualities for about forty-eight hours. The inoculated seed may be kept

however for several weeks, or even for months, before sowing and still retain all its power of growth.

It has been demonstrated that each legume has its own particular kind of bacteria, hence the Department of Agriculture always desires to know what seed is intended to be used.

These cultures were completed by the spring of 1904 and sent out to 12,000 farmers in every State in the Union and in many of the foreign countries including New Zealand, South Africa and Australia. This gave every variety of climate and soil for making the test and also all classes of farmers for trying the experiment, whether particularly adapted to such work or not. Of course all did not report the result, but the reports that were sent in showed an increase of 79 per cent. in the production. The rate of increase for the different legumes was as follows: Alfalfa, 73 per cent.; red clover, 92 per cent.; garden peas, 87 per cent.; common bean, 80 per cent.; cow pea, 85 per cent.; soy bean, 51 per cent.; hairy vetch, 75 per cent., and crimson clover, 88 per cent. This certainly indicates a remarkable result and plainly shows that there is something in this method of increasing the fertility of the soil.

My own experiments extend over only the past season. I ordered my supplies in November, 1904, and they were sent to me February 1, 1905. I inoculated four and one-fourth bushels of red clover seed with two supplies of bacteria. I sowed the seed on 25 acres of land, most of which was in wheat. For comparison I sowed a strip that was not inoculated. The sowing occurred between April 4 and 10. Anxiously I watched the growing seed. As soon as the nodules began to form I could notice more nodules on the inoculated plants than on the uninoculated ones. This increase has continued throughout the season. In comparing the stand of clover with neighboring fields it is plainly seen that it is better, the plants more vigorous and healthful.

My experiments have not been as successful as I anticipated, yet I feel that it has been very encouraging and that it can be of service to the farmers in southeast Indiana. Many farmers already in various parts of the country have succeeded in getting a stand of clover or alfalfa where it had previously been impossible to get it to grow.

It might also be stated in this connection that soil which has been growing clover becomes inoculated, and this soil can be sprinkled over another field and it will become inoculated. When the soil is once inocu-

lated it remains rich in these germs and thus insures the perpetuity of the power of gathering nitrogen from the air. It may take a number of years to make the people see the advantage of this inoculation, but when it is shown that there is an actual increase in the production, the farmers will not be slow to take up with the method. I expect to continue my experiments, and already have supplies engaged for another season.

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