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B. T. GALLOWAY, Chief of Bureau.

THE FERTILIZING VALUE OF HAIRY VETCH FOR CONNECTICUT TOBACCO FIELDS.

By T. R. ROBINSON,

Assistant Physiologist, Soil Bacteriology Investigations.

INTRODUCTION.

In connection with the introduction of a leguminous cover crop on tobacco lands in Connecticut it became at once desirable to know to what extent such a crop would lessen the need for fertilizers, especially those supplying nitrogen. Many experiments, mainly based on analyses of legumes, might be cited to show the amount of nitrogen which legumes furnish to a succeeding crop. Their very disparity serves to indicate, however, that the results may be largely influenced by soil and climatic conditions, so that for any one locality the results obtained elsewhere might prove misleading.

ADAPTABILITY OF HAIRY VETCH TO TOBACCO FIELDS.

Mr. A. D. Shamel, of the Bureau of Plant Industry, published in 1905, in cooperation with the Connecticut Agricultural Experiment Station, the preliminary facts in regard to "a new and valuable cover crop for tobacco fields," namely, Russian or hairy vetch (*Vicia villosa*).¹ This legume was found to be resistant to cold, heat, and drought; occupied the ground during the fall, winter, and spring; decayed rapidly when turned under; and enriched the soil by its ability to "fix" or utilize atmospheric nitrogen when properly inoculated—that is, when the bacteria were present to cause the formation of root nodules. Unless the bacteria were artificially supplied it was found that the desired inoculation was lacking or very tardy on the tobacco lands of the Connecticut Valley.²

¹ See Conn. Agr. Expt. Sta. Bul. 149.

² "The roots of plants from inoculated seed bore many tubercles, some aggregations of them being as large as corn kernels. When the seed was not inoculated the roots bore few, if any, nodules and the growth of the plants was much less vigorous." (Conn. Agr. Expt. Sta. Bul. 149, p. 6.)

IMPORTANCE OF INOCULATING HAIRY VETCH.

If hairy vetch was to prove at all valuable as a fertilizer, it was necessary to get the crop well inoculated. Plat experiments in collaboration with Mr. Shamel were therefore undertaken in the autumn of 1906 at Hockanum, Conn., by the Office of Soil Bacteriology Investigations to determine, if possible, the value of hairy vetch as a fertilizer on the soil of that region. Tobacco following uninoculated vetch has shown but little advantage over that following a rye cover crop, but where hairy vetch has been inoculated and an abundance of root nodules have resulted the tobacco following has been greatly benefited both as to yield and as to quality. When one compares the growth of inoculated and uninoculated vetch this will be easily understood.

The yield of hairy vetch in 1907 at Hockanum, Conn., as found from sample cuttings on 1 square rod of our test plats, amounted to 7 tons 400 pounds an acre (green weight) for the inoculated vetch and 2 tons 240 pounds an acre for the uninoculated vetch. Rye on this land made a vigorous growth, yielding at the rate of 7 tons 720 pounds an acre.

To determine further whether the difference in yield in this test could be due to any difference in soil nitrogen, determinations of total nitrogen in samples of the soil were made by the Bureau of Chemistry. It was found that the soil where vetch was growing without inoculation contained 0.19 per cent of total nitrogen, or more than that found on either the plats of rye (0.17 per cent) or inoculated vetch (0.14 per cent). Yet with this greater source of nitrogen in the soil the vetch lacking nodules made less than one-third the growth attained where the plants were properly inoculated. It may be said that in one case nodules were absolutely lacking, while in the other the nodules were so abundant that when the vetch was plowed under the upturned soil was dotted white with the glistening nodules.

POT EXPERIMENTS WITH HAIRY VETCH.

To check under controlled conditions the results obtained in the tests at Hockanum, Conn., a quantity of soil from the uninoculated plat was shipped to Washington and some experiments were undertaken in the greenhouse. This soil was placed in large pots (holding about 30 pounds of soil each) and planted with seed of hairy vetch, ten plants to a pot. One-half of the pots were sown with seed treated with a pure culture of the vetch-nodule organism, the remainder being untreated. The pots were watered throughout with water sterilized by boiling. Despite this precaution and a preliminary sterilizing of the pots and seeds, a partial inoculation of the control plants took place—probably due to insects traveling from the inoculated pots. This chance inoculation occurred, however, too late to benefit the control plants as much

as those inoculated at the start, and the difference was still noticeable after three months' growth (December 11, 1907, to March 19, 1908).

Rye was grown under the same conditions but did not make a very good growth. Plants were taken off for weighing when flowers began to appear, and samples from each lot were analyzed. The results are shown in the following table:

TABLE I.—*Results of greenhouse tests of rye and inoculated and uninoculated hairy vetch.*

Two pots, containing twenty plants.	Green weight.	Dry weight.	Nitrogen.	Total nitrogen furnished by plants.
	<i>Grams.</i>	<i>Grams.</i>	<i>Per cent.</i>	<i>Grams.</i>
Hairy vetch, control plants.....	148.5	25	3.41	0.82
Hairy vetch, inoculated plants.....	215.5	44	3.49	1.33
Rye.....	72	16	1.69	0.27

It will be seen that even when partial inoculation of the vetch took place the highest results both as to yield and percentage of nitrogen were obtained when artificial inoculation was practiced and that both lots of the legume were superior to rye in furnishing nitrogen.

As a check against chance inoculation, a few small pots of the same soil as that used in the greenhouse test were sterilized by autoclaving for 1 hour at 140° C., part of them being planted with inoculated vetch seed. The pots were kept in a glass cage, carefully protected against insects or dust infection, and were watered with sterile distilled water. The checks remained free of nodules throughout the experiment, while those inoculated were plentifully supplied with nodules. The soils were so injured by the heating that neither set of plants made a normal growth, their chief difference being in color. The check plants were pale green, while the inoculated plants were healthy in color.

NITROGEN FURNISHED BY HAIRY VETCH TURNED UNDER.

If the percentages shown in Table I are taken as representing the nitrogen content of the field-grown vetch previously mentioned, it will be seen what an enormous gain was effected by abundant inoculation. Assuming one-fifth of the green weight to represent the dry weight of the vetch, the following amounts of nitrogen were furnished on the cover-crop plats at Hockanum, Conn.:

TABLE II.—*Comparison of nitrogen in cover crops of rye and inoculated and uninoculated hairy vetch grown at Hockanum, Conn.*

Plat.	Green weight, per acre.	Dry weight, per acre.	Nitrogen.	
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds per acre.</i>
Hairy vetch, inoculated.....	14,400	2,880	3.49	100.51
Hairy vetch, uninoculated.....	4,240	848	3.41	28.91
Rye.....	14,720	2,944	1.69	49.75

The difference in the quantities of nitrogen furnished by the two lots of field-grown vetch is probably even greater than that shown here, owing to the partial inoculation of the pot-grown vetch plants from which the percentage of nitrogen was obtained. It is not to be concluded, however, that 100.51 pounds of nitrogen in one case represents the net gain from growing inoculated vetch, or even that the difference between 100.51 pounds and 28.91 pounds (71.6 pounds) represents exactly the amount of nitrogen abstracted from the air by the root-nodule bacteria. A very considerable part of the nitrogen even in the case of an inoculated plant is derived from the soil. The more vigorous the plant and more wide spreading its root system, the greater will be its ability to secure nitrogen from the soil.

If, however, this 71.6 pounds of nitrogen is counted as clear gain (that is, taken from the store of atmospheric nitrogen) it can not be assumed that this becomes at once available for the succeeding crop. There is reason to believe that the greater portion of it becomes available under favorable conditions within a comparatively short time, but it can not be stated as proved, for instance, that this amount of nitrogen turned under (71.6 pounds) is equivalent to the application of 475 pounds of nitrate of soda (15 per cent nitrogen).

POT EXPERIMENTS WITH TOBACCO.

To carry the pot experiments still farther the soil in each pot was thoroughly stirred and prepared for setting out tobacco plants. In part of the series the vetch or rye was turned under and in part removed entirely from the pot. The pots were kept moist for four weeks, tap water being used, to allow for the decomposition of the plants turned under.

Sodium nitrate was chosen as a carrier of nitrogen to compare with that furnished by the plants turned under and was supplied at the rate of 200 pounds to the acre three days before setting out the tobacco plants. To get the maximum effect of this fertilizer some duplicate pots on which no cover crop had been grown were fertilized at the rate of 200 and 500 pounds of sodium nitrate to the acre.

Selected tobacco plants from Connecticut seed, apparently of equal size and vigor, were set out in the pots, a single plant to a pot. The pots were watered with tap water from this time to the completion of the experiments (April 16 to July 22, 1908). The tobacco did not do especially well under greenhouse conditions, but all plants were affected alike. As all the vetch plants turned under were considerably inoculated when taken up, no separate account was kept of the inoculated and control series. The fertilizer used was 200 pounds of sodium nitrate to the acre. The results, given in terms of the green weights of the plants cut off at the surface of the soil, follow:

Cover crop and method of use.	Treatment.	Ounces of tobacco. ^a
Hairy vetch turned under.....	No fertilizer.....	5.75
Hairy vetch removed.....	Fertilized.....	5.28
Hairy vetch turned under.....	Fertilized.....	7.75
Rye turned under.....	No fertilizer.....	4.25
Rye removed.....	Fertilized.....	5.25
Rye turned under.....	Fertilized.....	6.25

^aAverage of four pots.

It would thus appear that the turning under of the inoculated hairy vetch was slightly superior to the application of 200 pounds of sodium nitrate to the acre, while the turning under of rye was inferior to the application of the fertilizer. When the cover crops were turned under and fertilizer added the vetch again showed greater fertilizing power than rye. In pots which had borne no cover crop the application of nitrate of soda at the rate of 500 pounds to the acre was no more effective than the use of 200 pounds to the acre.

CONCLUSIONS.

In presenting this report, no mention has been made of the influence on the soil of the hairy vetch crop aside from its property when inoculated of furnishing nitrogen, thus allowing a considerable reduction in quantity of the expensive nitrogenous fertilizers. As a preventive of wind and water erosion the matlike growth of hairy vetch gives it great value; as a source of humus its extensive root system and the readily decomposable nature of the whole plant are peculiar advantages, and it seems to possess in addition, on land successively cropped to tobacco, a green-manuring value considerably above its purely chemical content and the physical improvement of the soil resulting from its use. The full nature and amount of these benefits will require more extensive tests, but the results here reported are presented as a partial guide to those interested in the utilization of hairy vetch as a cover and fertilizing crop.