ROTHAMSTED RESEARCH

The Growing of Lucerne

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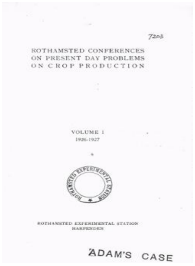

Lucerne Inoculation Trials

H. G. Thornton

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is so new that much still remains to be learned, and one purpose of this Conference is to obtain from practical growers accounts of their difficulties, so that the experimental programme can be made to give better and more useful knowledge.

LUCERNE INOCULATION TRIALS

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The experiments upon which I wish to open a discussion concern the treatment of lucerne seed with cultures of *Bacillus radicicola*, the micro-organism that produces nodules upon the roots of leguminous plants. It has long been known that the organisms living in the nodules are beneficial to the crop, owing to the fact that they build up from the free nitrogen of the atmosphere compounds that the plant is able to utilise.

As long ago as the nineties Nobbe and Hiltner developed the idea of artificially supplying leguminous crops with the nodule bacteria. The early trials of legume seed inoculation gave very variable and unsatisfactory results, but with the extension of our knowledge of the principles concerned there has been greater success in recent years, and the inoculation of certain crops has become a recognised practice in many parts of the world, especially in America and Scandinavia. The failure of the process in the early years of its use seems to have been due partly to faulty technique and partly to its application to unsuitable crops.

In recent years the methods of storing the bacteria in the laboratory have been improved, so that they can now be kept without loss of vitality, and the media upon which they are issued to the farmer have been modified so that, on the new media now used, fresh cultures can be prepared at very short notice.

The exact method used to apply the bacteria to the seed appears also to be of importance, as their activity in the soil may be affected thereby. Recent work in the laboratory has shown that the bacteria pass through a definite cycle of changing forms in the soil. During certain stages in their life-cycle they are actively motile and, in this condition, are able to migrate through the soil. When inoculated seed is sown the bacteria have to pass through the soil to reach the various parts of the root system where the nodules are produced. The timely appearance of the motile forms in the soil is thus of vital importance. The nature of the fluid used to convey the bacteria to the soil influences both the time of appearance and the relative members of these motile stages. It produces a corresponding influence on the migration of the bacteria through the soil,

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example, when a suspension of the bacteria in *water* was added ıe soil it took three days before they began to spread away the point of inoculation. When a suspension in *milk* was d, the initial rest-period was reduced to forty-eight hours, while a suspension in *milk and calcium phosphate* the bacteria began ›read after twelve hours. The addition of calcium phosphate to milk thus stimulates the bacteria to migrate through the soil increases the volume of soil infected by them in a given time. the common method of inoculating seed is to wet it with a ›ension of the bacteria in skim milk. Pot experiments were efore made to see whether the addition of calcium phosphate to milk would increase the effect of inoculation. The phosphate was ıd to increase the number of nodules produced very consider- and also to improve the crop. Thus not only has laboratory erience enabled us to maintain healthier cultures of the nodule teria, but recent knowledge of its life in the soil has modified our hod of applying these to the seed.

A second cause of some of the early failures with inoculation the application of the process to unsuitable crops. It is now ›wn that the nodule-forming bacteria are divided into varieties, h of which is able to infect only one or at most a few kinds legumes. Now some of these varieties are almost universally sent in our soil. For instance the organism that produces lules on clover is found even in the tap water of this laboratory. such cases inoculation can scarcely be expected to benefit the ›p. On the other hand certain crops that have been introduced o the country do not find the correct variety of the organism in r soil unless this is in some way introduced, and it is there that ›culation is likely to be helpful. Lucerne is a crop of this kind. was introduced into England about 1630, but since that time its owth has extended very little beyond the South-Eastern counties. ithin this area it is extensively grown and usually develops dules on its roots without inoculation, showing that the soil has, the course of centuries, become infected with the lucerne nodule ganism. Attempts to grow it in the West and North of Great itain meet with very uncertain results; and while some failures re can be attributed to climate, the evidence indicates that the ›sence of the lucerne nodule organism from the soil is another ıportant factor.

We therefore decided to make a large-scale test of the value lucerne inoculation in this country. For the reasons explained it as expected that in certain areas inoculation would be beneficial, hile in other districts the presence of the bacteria in the soil ould render inoculation superfluous. It was therefore necessary › make trials at places distributed all over the country to find out there were districts where the process would be profitable.

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Experiments are now in progress at some fifty centres distributed over Great Britain. They are being carried out by agricultural colleges, farm institutes and private individuals whose ready co-operation has made the tests possible. The Royal Agricultural Society has made grants towards the cost of the work. The tests were commenced in 1924, but the very wet summer of that year resulted in the loss of some of the trials and a further series were started this year. At the present time there are thirty-one trials in progress. The majority of these were commenced too late to enable cuttings to be weighed, but in eight cases this was done, and in seven of these the inoculation was found to produce a benefit either in weight or in the nitrogen content of the crop. These results are briefly summarised in the following list showing the percentage increase due to inoculation at trials in each county named :—

Kincardineshire	10, 40, 17 per cent.	Gloucester	179 per cent.
Durham	16·8 ,,	Wilts	141 ,,
Staffordshire	2 ,,	Cornwall	31 ,,
Warwickshire	35 ,,		

In the case of the Staffordshire trial the difference in yield is insignificant, but there was an increase of 48 per cent. in the percentage of nitrogen in the hay. Since this nitrogen is mostly in the form of albuminoid it will be seen that, here also, the food value of the crop has been greatly increased by the treatment. A great difficulty in the experimental work is due to the fact that the bacteria spread from the inoculated into the uninoculated strips, so that the increase due to the treatment appears less in the trials than would have been found under field conditions. In some trials a marked benefit from the treatment has been observed, but it has not yet been possible to confirm this observation by weighings. If one plots the distribution of all the stations where inoculation has shown a benefit, it is seen that outside the South-Eastern counties twenty-two centres out of twenty-eight show a benefit. The remaining centres have in most cases been sown late in the season and may show an effect next spring. The conclusion seems justifiable that in these districts inoculation should always be adopted save on fields known to have grown good lucerne crops before. There are indeed cases where inoculation has enabled good lucerne to be grown on land that has never before successfully grown it. Within the South-Eastern counties the advantages of inoculation are still doubtful. There are three centres where a benefit has been obtained, but it is likely that a local presence or absence of the lucerne bacteria in the soil will make it impossible to predict the effects of inoculation in this area. We hope, however, to obtain more evidence from fresh centres in this area during the coming year.

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Inoculation should chiefly help us by enabling the area of successful growth to be extended. To do this, however, there are two limiting factors to be overcome: the cold winters of the North and the weeds due to wet weather in the West. It is possible that some of the Canadian or Scandinavian varieties of lucerne may be sufficiently cold-resistant to grow in the North, and this possibility is being tested. The weed problem, however, has always been paramount. There seem to be two possible ways of dealing with it. One is late sowing. In the course of our trials sowing has been carried out at times ranging from April till August, and the best and cleanest have been those sown in July, since it is then possible to clean out the majority of annual weeds before sowing. The second possibility is to use some cover crop. It is recognised that in the Eastern counties a cover crop is undesirable, but in the West one is often faced with the alternative of having an intentional cover crop or an unintentional cover of weeds. The weakening effect of a cover crop is largely due to its removing nitrogen from the young lucerne. Inoculation renders the plant more independent of soil nitrogen, so that the cover crop then does little harm in this way. For this reason our trials have shown that where a cover crop is used, inoculation is the more necessary.

I feel that this problem of weed suppression is vital in the extension of lucerne growing, and I hope it will be discussed by those more competent to do so.

SOME SCOTTISH EXPERIMENTS WITH LUCERNE

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The experiments with lucerne carried out by the Edinburgh and East of Scotland College of Agriculture were begun in 1920. In that year a culture for the inoculation of lucerne was received from the United States Department of Agriculture with a request that it should be tested. An experiment to test the effect of inoculation was carried out at Seton Mains, East Lothian, on land which showed a lime requirement (Hutchinson and MacLennan's method) of 1 ton calcium carbonate per acre. The inoculation was applied to the seed. The crop was a complete failure.

An endeavour was made to ascertain whether lucerne was grown satisfactorily anywhere within the College area at this time. Three small plots were discovered—one at Pathhead, Midlothian, one at Newtown St Boswells, Roxburghshire, and one at Cupar, Fife. All

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