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Report for 1929

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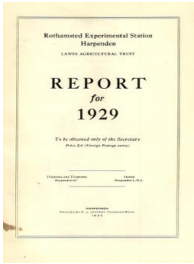

Effluent from Sugar Factories

Rothamsted Research

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beans carried more nodules as the result of adding chaff to the soil. Where there are no nodules, the beans suffered from the addition of straw, just as a non-leguminous crop would have done.

This work is being developed simultaneously with the study of the closely allied subject of green manuring. The Woburn experiments show that green manuring does not increase the yield of crops as much as was expected, and tares proved even less effective than mustard. 1929 has been the only exception: in all other years the green crop, whether fed off by sheep or ploughed under, has failed to increase the succeeding crop. One factor is the very small amount of nitrate and ammonia in the soil; even on the folded land the average contents of nitrate nitrogen in the top soil after tares and mustard respectively, were only 1.3 and 1.0 parts per million. Addition of nitrate of soda pushed up the yields considerably.

The decomposition process is very complex and cannot be understood from a study of one section only. Bacteria play a great part, which is not yet, however, fully known. Dr. Thornton's improved method of counting them shows that they are far more numerous than was formerly supposed. Their numbers are not constant, but fluctuate with amazing rapidity from hour to hour during the day. The fluctuations are not clearly related to temperature or soil moisture changes: they may have something to do with the method of reproduction of the organisms, but this is not known. The amount of decomposition effected by the bacteria increases with their numbers, but not proportionally: the efficiency of the individual organisms falls off as their numbers increase. The position is somewhat altered when amoebæ are present: the production of carbon dioxide is then depressed in media relatively rich in nitrogen compounds, such as sand cultures containing peptone, but it is increased in media poor in nitrogen and containing glucose or soil extract.

Perhaps the most striking discovery in the Microbiological Department this year has been that of a group of nitrifying organisms producing nitrites from various ammonium salts, but differing completely from the only forms previously known, *Nitrosomonas* and *Nitrosococcus*, in that they thrive in the presence of organic matter. They were first found in the effluent from the Colwick sugar beet factory, where we have been studying the problems of effluent purification: Mr. Cutler has since found them commonly distributed in the soil.

Effluent from Sugar Beet Factories. For the past three years the Fermentation and Microbiological Departments have been studying methods of purifying the effluent from sugar beet factories so as to render it harmless to the rivers into which it is poured, and their work has been so successful that a 90% purification was obtained in 1929 in the large scale experiment at the Colwick factory. This exceeds the required standard. The essential feature of the method is to pass the effluent over a clinker filter so that the sugar may oxidise completely before it enters the river. More time is needed than for sewage purification, hence a finer grade of clinker is needed. There still remains the difficulty that the mud suspended in the water may choke the filter before the end of the campaign, but this, too, can be overcome.

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There is now no justification for pollution of rivers by sugar beet factories: they can either set up a purification plant or they can obviate the difficulty by using their water over and over again, as is already done by some processes.

Two detailed reports on this work have been presented to the Water Pollution Research Board of the D.S.I.R., and these have been circulated, for official use only, as Papers No. 36 and 41, under dates 22.11.28 and 21.3.29, respectively. A brief account of the investigation, supplied by the Department, was published in "The Times" of the 28th October, 1929.

SOIL CULTIVATION.

The investigations on soil cultivation are carried out by the staff of the Soil Physics Department. Their underlying purpose is to reduce the art of cultivation to a science, just as the chemists and plant physiologists of the period 1800 to 1840 reduced the old art of manuring to a science and so paved the way for the introduction of artificial fertilisers as the result of the early Rothamsted experiments.

The work is developing in three directions: the effect of cultivation on the soil, the physical properties of the soil, and new methods of cultivation, are all under investigation.

Methods have been devised for estimating the degree of breaking up of the soil, *i.e.*, its comminution, also for estimating the surface. The effect of ploughing in breaking up the soil and increasing its surface is shown by the following results:—

	RELATIVE SURFACE OF SOIL.		
	Before Cultivation	After Ordinary Ploughing	After Rotary Cultivation
(*a*) Soil compact	320	475	530
(*b*) Soil looser ...	440	420	—
Relative sizes of soil particles in (*a*): Percentage distribution.			
Large	60	45	30
Medium ...	33	40	55
Small	7	13	13

Dynamometer measurements are taken of the amount of work done in cultivating the soil, and the records are studied in relation to the physical properties involved. The figures are closely related to the "static rigidity" of the soil, *i.e.*, the energy needed to set flowing a paste made up from the soil. This has led to some interesting developments in the study of the plasticity of the soil, and in order to forward the work the Rockefeller Foundation gave Mr. Scott Blair a Fellowship, enabling him to spend a year in the United States working with Prof. Bancroft, who is studying cognate problems in the Cornell Laboratories.

The experiments on rotary cultivation were continued to see whether it gave as good a seed-bed as the ordinary processes for barley after roots. It proved to be equally effective; indeed, for germination and initial growth it was better, and, of course, it was quicker and cheaper, as it made the seed-bed complete in one operation. This result we have had in the preceding trials, excepting where rotary cultivation caused a "cap" to form on the soil, and then its effect was not so good. It seems probable, however, that this tendency can be overcome.