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Physical Properties of the Soil

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statement is true when the grinding is done by the standard method ; as the nitrogen content increases, barley gives progressively less extract than corresponds with replacement of the carbohydrate by the additional protein ; with finer grinding, however, the full amount of extract is obtained. The result suggests some sealing up or rendering inaccessible of carbohydrate in barleys of high nitrogen content.

Finally, the weather conditions determining the nitrogen content of the grain have been so fully worked out that predictions made at the end of June are found to be closely fulfilled when the grain is analysed after the harvest in August.

THE SOIL : PHYSICAL PROPERTIES

The main purpose of the work in the Physics Department is to study the physical properties of the soil, especially those related to water, air movements, temperature and formation of tilth. The water relations have been much studied by Dr. Keen, who has devised methods of investigation and shown how to interpret the results ; he is also studying the temperature relations. Plasticity is studied by G. W. Scott Blair and R. K. Schofield, and the crumb structure by E. W. Russell ; while Dr. Schofield is improving the methods for determining the quantity and kind of exchangeable bases in the ultimate clay particle, a factor now known to have great importance in determining soil properties.

Some of the applications of the work are in the direction of cultivation ; at present this is an art but hardly a science ; it is not nearly so advanced as the science of manuring. Experiments on the farm have shown some of the advantages and some of the disadvantages of rotary cultivation as compared with the older methods ; these are dealt with in previous reports. Other experiments are made with intensive as against ordinary cultivation. Last year's results (1932) show that neither potatoes, sugar beet, nor kale responded to cultivation more intensive than was necessary to keep down weeds ; indeed, further cultivations beyond this minimum amount did more harm than good.

Other applications of the work are to soil surveying. Usually a soil surveyor has to work rapidly over a large area and unless he relies entirely upon personal judgment in classifying the soils he must have rapid methods of characterising them. Various easily-measured properties have from time to time been suggested as sufficient for soil characterisation ; a number of these were applied by J. R. Coutts to an extensive range of soils, and the data have been statistically examined by E. W. Russell so as to find out which methods give the most useful information.

Considerable attention is being paid to the meaning of soil tilth and the factors concerned in crumb structure. One of the important properties of the soil crumbs is their stability towards water, crumbs that will persist when moist are much more conducive to productivity than crumbs which readily break down. Stability depends on the composition of the clay ; it is greater for a calcium clay than for others, and it is enhanced by micro-organic action, apparently through the formation of a film on the surface.

Crumb formation in soils and its related phenomena are due to interaction between the clay particles and the water present, and methods are being developed to elucidate the details of this interaction. By comparing the properties of clays dispersed in water and in organic liquids it is possible to pick out those particular properties of the water and organic liquid molecules responsible for any given property of the dispersion. Thus crumbs can be formed from clay dispersed in the alcohols, aniline, and nitrobenzene, but not from clays dispersed in a hydrocarbon, indicating that their formation depends on the presence of an appreciable dipole moment in the molecules of the dispersion medium.

The methods for studying the plasticity of clay can be used equally well for studying the properties of dough, and this is being done by G. W. Scott Blair and R. K. Schofield. The way in which viscosity and relaxation time vary with stress and strain has been discovered, and efforts are now being made to test the constancy of the rigidity modulus under varying stress and the influence of the "stress-history" of the dough on the modulus. Certain aspects likely to lead to results of milling interest are being studied in conjunction with the Research Association of British Flour Millers.

THE SOIL : ITS CHEMICAL COMPOSITION AND PROPERTIES

The Chemical Department is concerned with the study of the composition of soils and of crops ; it also does a great amount of analysis for other departments, particularly in connection with the field experiments.

The study of the soil has been greatly advanced in recent years with the development of ideas on the constitution of the clay fraction of the soil. The clay is now regarded as analogous to a salt, being made up of a basic and an acidic portion ; it can interact with salts forming new clays differing from the original as a salt of one metal differs from the salt of another metal. The forces of attraction between the acidic part of the clay and the basic part, and the attraction between the whole complex clay and other substances, are now being studied by modern physico-chemical methods and relations hitherto unsuspected are being found between the chemical and physical properties of soil.

With this new knowledge it has been found possible to reopen many old problems, among them the question of soil analysis, which many soil chemists had given up in despair. Work on the exchangeable bases and the buffer capacities of soils has suggested means of overcoming the more serious defects of the older empirical methods of soil analysis and so giving analytical data which are constant for the soil concerned and do not depend, like the old figures, on the particular analytical procedure adopted. This work is facilitated by the steadily-increasing supply of soil samples from plots on which good field experiments have been carried out so that the response to fertilisers is known.

THE CHANGES IN THE SOIL ORGANIC MATTER

Hitherto the method adopted at Rothamsted for studying the changes in the soil organic matter has been to compare the quantities