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ROTHAMSTED RESEARCH

Rothamsted Report for 1932

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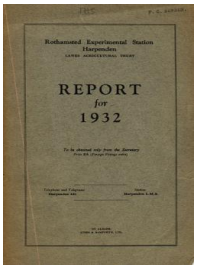

Composition of the Barley Crop

Rothamsted Research

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purchase a larger proportion of barley coming from those countries where the harvest weather was better than in this country.

THE COMPOSITION OF CROPS

Barley

Four crops have in recent years been studied in the chemical department : barley, sugar beet, potatoes and wheat—but the most extensive investigations have been with barley, carried out in association with the Institute of Brewing. The relation between the chemical composition of barley and its grade as assessed by the buyer is shown in Table IX.

TABLE IX.—Grades of Barley as assessed by the valuers, and their chemical composition.

Grade awarded by Valuer.	Type.	No. of Centre Averages.	*Barley.*		*Malt.*	
			Nitrogen per cent. in dry grain.	1,000 corn wt. gms.	Extract lb. per qr.	Diastatic Power.
I. ..	Pale Ale	2	1.558	42.6	100.0	35.1
II. ..		7	1.416	40.6	100.6	29.9
III. ..		11	1.486	40.2	99.7	33.6
IV. ..	Mild Ale	13	1.491	39.0	98.6	28.4
V. ..		24	1.554	38.5	98.5	39.6
VI. ..		25	1.686	38.1	97.6	44.0
VII. ..	Grinding	8	1.592	37.8	97.8	42.7

The close connection between the grading and the composition of the barley is very remarkable in view of the facts that the grading was done independently of the analysis and that it was greatly influenced by the degree of ripening of the barley which has nothing at all to do with the nitrogen content. Yet apart from Grade I (of which there are only a few samples) the grading becomes lower as the nitrogen content rises, and as the 1,000 corn weight decreases. Field experiments have been made to find out how the nitrogen content is related to the conditions of growth of the crop ; these are dealt with on p. 35.

From the scientific point of view, perhaps the most interesting result is the close relation established by Dr. Bishop between the quantities of the different nitrogen compounds in the barley grain and the total nitrogen. The quantities of hordein, glutelin and of the other nitrogen compounds are always closely related to one another and to the total nitrogen. Barleys of the Plumage-Archer type contain, at 1.35-1.5 per cent. of nitrogen, about equal proportions of hordein, glutelin and salt-soluble nitrogen compounds in the fully mature grain.* Barleys of lower nitrogen content contain somewhat less hordein, but barleys of higher nitrogen content contain much more†, with correspondingly less salt-soluble nitrogen compounds.

* i.e. after about three years' storage. In immature grain the percentage of salt-soluble nitrogen is higher, and of glutelin and hordein lower, than in mature grain.

† They are, as Dr. Beaven pointed out, frequently steely, but there is nothing to show that the steeliness is due to any special proportions of the individual proteins. An explanation based on physical properties is much more satisfactory.

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Of all the many samples of barleys examined, none has ever been found to contain an abnormal proportion of hordein or of glutelin ; the relations seem to hold invariably and to be characteristic of the variety. Similar regular relations apparently occur between the carbohydrates in the grain.

It appears, therefore, that each variety of barley is built up on a definite pattern, which can be altered by changes in conditions, but only within the limits set by the pattern, so that the variety always retains its distinctive character. Knowing the percentage of nitrogen in a particular sample, it is possible to state at once the whole composition of the grain as we know it at present.

Different varieties have different patterns and the differences are more marked among the six-rowed than among the two-rowed varieties, but in no conditions so far discovered do the patterns merge or lose their distinctiveness. The differences between different varieties constantly reappear in all the tests made under normal agricultural conditions, though there are some reversals of effects under conditions of abnormal starvation. The character of the pattern can by plant-breeding methods be changed within limits defined by the laws of genetics ; within these limits new varieties having different proportions of the various nitrogen compounds and carbohydrates can be produced. Some of these varieties may be better suited than existing sorts to the special requirements of different groups of maltsters and brewers. There seems, however, to be no necessity for a large number of varieties, and it would probably be to the advantage of all concerned if growers, maltsters and brewers could agree to concentrate on a few standard sorts. Plumage-Archer and Spratt-Archer are distinctly superior to others in yield, low nitrogen content and high extract.

Another important result has been to confirm and extend an observation made at Rothamsted some 25 years ago, that the nitrogen content of the grain is determined in the early stages of the plant's life and does not appreciably alter during the later development of the grain. This is quite contrary to the general belief : the nitrogen content of the barley was supposed to be determined largely by the conditions in the later part of the plant's life ; it was associated with the maturation ; too rapid or delayed maturation was supposed to lead to high nitrogen content and *vice versa*. The recent results obtained in collaboration with the Institute of Brewing show that the nitrogen content of the grain is determined in the earlier part, and not in the later part of the plant's life, and that it is hardly affected by the maturation processes. Maturation of course still remains an outstanding factor in determining malting value, probably accounting for a large part of the missing factor that places Grade I barleys above the position to which their chemical composition would assign them. A barley grain rich in nitrogen does not normally mature as well, judged by the maltsters' standards, as a grain poor in nitrogen. Usually also an increase in the nitrogen content of the grain is associated with an increased proportion of immature grains. It has been stated that the carbohydrate of a high nitrogen barley is not so completely transformable into extract as that of a low nitrogen barley, and this has been taken as evidence of a connection between maturation and nitrogen content. The

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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 productiveness 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.

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