ROTHAMSTED RESEARCH

Rothamsted Report for 1932

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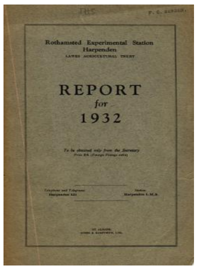
REPORT
for
1932

Barley

Rothamsted Research

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The effect does not appear to be due to the nitrate accumulated during the bastard fallow, since addition of sulphate of ammonia as fertiliser did not alter the numbers of plants. As the summer advanced certain differences set in which entirely compensated for the differences in plant number. The plants in the less densely populated plots tillered better, produced more ears per plant with more grains per ear than those on the more densely populated plots, with the result that at harvest there was no difference in yield between any of the four treatments, in spite of the initial differences in plant number. The later measurements are given in Table VI.

TABLE VI.—Further particulars of wheat plants of Table V.

		After Clover.		*After Clover and Ryegrass.*	
		Cut once.	Cut twice.	Cut once.	Cut twice.
Number of Shoots—					
Feb. 25	per metre ..	48.7	31.0	44.9	34.4
	per plant ..	1.11	1.10	1.09	1.10
Mar. 22	per metre ..	64.3	43.2	58.3	52.5
	per plant ..	1.66	1.57	1.59	1.58
April 29	per metre ..	78.7	69.1	71.9	69.6
	per plant ..	3.45	3.58	3.35	3.49
Number of ears at harvest—					
	per metre ..	45.5	44.7	43.5	41.5
	per plant ..	1.39	1.69	1.40	1.51
Weight of grain per ear, grams		1.136	1.198	1.161	1.204
Yield, cwt. per acre, grain	..	26.6	27.6	26.0	27.2

This compensation of winter killing by extra tillering has been observed before on our fields, and is one of the most important factors in steadying the yield of wheat.

BARLEY

Sowing barley late tends to lower the yield and the 1,000 corn weight and raises the nitrogen content. Experiments were made to see if treatment with sulphate of ammonia or superphosphate would mitigate these ill effects, but it did not; neither fertiliser benefited the late sown crop. (Table VII.) A similar result was obtained some years ago with sugar beet; indeed, up to the present we know of no way in which the harmful effects of late sowing can be overcome.

TABLE VII. Effect of date of sowing on properties of Barley Grain. (Plumage-Archer)

	No Fertiliser.	Sulphate of Ammonia	Superphosphate.	Sulphate of Ammonia and Superphosphate.
Yield, cwt. per acre.				
Sown—early	25.9	32.9	28.2	32.8
late	23.2	25.3	25.3	26.4
1,000 corn weight (grams) dry.				
Sown—early	47.0	47.2	47.4	46.5
late	44.4	44.2	44.4	44.7
Nitrogen per cent. on dry grain.				
Sown—early	1.70	1.68	1.67	1.70
late	1.80	1.90	1.82	1.84

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For some years past experiments have been made to see whether the different varieties of barley responded in the same way to fertilisers or whether of two varieties one might be better under one fertiliser treatment and the other be better under another treatment. Spratt-Archer and Plumage-Archer were tested at Rothamsted, and Plumage and Archer at Woburn. No differential effects, however, were observed: Spratt-Archer was always the better at Rothamsted, except under potash starvation, when both were alike, and Archer was always the better at Woburn. (Table VIII.)

TABLE VIII.—Comparison of yields, Nitrogen content, and 1,000 corn weight. Spratt-Archer and Plumage-Archer, Hoosfield, Rothamsted—4 years, 1929-32.

Manurial Conditions.	Yield of Spratt-Archer when Plumage-Archer = 100.	*Spratt-Archer above (+) or below (−) Plumage-Archer* ([1]). Nitrogen per cent.	1,000 Corn weight gms.
Farmyard Manure 7-2	115	+0.046	−2
Complete Artificials 4A	117	−0.010	−3
Nitrogen starvation 4O	121	−0.035	−2
Potash ,, 2A	98	−0.006	−7
Phosphate ,, 3A	112	+0.029	−5
Complete ,, 1O	111	−0.054	−5

([1]) 1930 only.

Plumage and Archer. Stackyard Field, Woburn. Yield of Plumage when Archer = 100.

	1931.	1932.	pH.
Farmyard Manure 11b	82	86	6.28
Complete Artificials 5b	76	—	6.75
,, ,, 6	82	84	6.23
Nitrogen starvation 4a	90	—	5.80
Potash ,, 10a	83	59	5.81
Phosphate ,, 11a	75	70	5.87
Complete ,, 1	69	80	5.83

MALTING BARLEY

The recent reduction in the tax on beer and the promise of the brewers to use as much English barley as is possible, has caused many farmers to hope for an increased demand for malting barley, and therefore for a larger income from this source than they have enjoyed for a long time past.

During the last ten years the Institute of Brewing has been carrying out investigations on barley and much of the work has been centred at Rothamsted. Field experiments have been made here, and at Woburn, also on a number of barley-growing farms in different parts of the country; their purpose was to find how the yield, composition and market valuation of barley are affected by soil, season and manuring, and they have given a vast amount of information of great value to the agricultural expert and to the barley grower.

At the outset it must be emphasised that the demand for malting barley is limited. Agriculturists must not suppose that by learning to grow malting barley they will necessarily be able to sell it at a high price. Even before the recent fall in the consumption of beer the amount of barley used in British beer was little more than three million quarters per annum, and only between two-thirds and three-fourths of this (largely dependent of harvest conditions) was bought from English growers. There remains always the hope and the possibility that a good deal of the remainder could be grown here also, and indeed none of the laboratory investigations yet made has shown anything in the character of the extract obtainable from imported foreign barleys that English barleys lack in good seasons. Most practical brewers maintain, however, that they cannot obtain the results they want without a proportion of the more husky six-rowed barley to assist drainage in the mash tun, and it is for the research worker to discover whether such barleys cannot be economically produced here so as to satisfy all requirements. This work is still going on. Agriculturists should also remember in comparing the relative demands for English and for Californian barley, that Californian barley contains much less water than ours—only about 10 to 12 per cent. as against 15 per cent. in a good year and 18 per cent. in a bad year for English barleys. In consequence Californian barley not only yields some 6 or 7 per cent. more malt per quarter than ours, but being drier it can be held in store at the docks or elsewhere for two years without any treatment not only without deterioration, but with frequent improvement; while British barley usually has to be kiln-dried, which is a troublesome business.

Meanwhile, in view of the restricted demand, it is only courting disappointment to attempt anything like overproduction of malting barley.

The chief factors in determining quality are the soil and the weather. Certain fields will nearly always produce good malting barleys (harvest conditions being favourable) others only rarely do so. Medium to light loams are the most trustworthy soils, heavy loams and sands come next, and fen soils and clays are the least likely to give good samples. Of all these soils the sandy ones are the most speculative; our best and our worst samples have come from them.

Of the varieties tested, Plumage-Archer and Spratt-Archer are the best, giving about 5 to 10 per cent. more yield than most others; Plumage-Archer yields slightly less but its 1,000 corn weight is better, and its average valuation is slightly above that of Spratt-Archer.

In regard to cultivation, fallow has in our experiments been the best previous treatment of the land both for yield and quality. In practice a dead fallow would be out of the question, excepting on a mechanised grain farm, but autumn cultivation would be the next best thing. This could be given after a preceding grain crop or after a seeds ley. What form the cultivation should take must, of course, be determined by the actual conditions of the farm, but it should give as nearly as is possible the effects of a bastard fallow.

Against the benefits of the fallow must be set the loss of nitrogen involved, but it remains to be seen how far this would be made good by the clover in the seeds break. Barley will not tolerate acidity of the soil, and the Woburn experiments show that it suffers more easily from this cause than any of the other cereals. The first sign of acidity is patchiness in the crop ; the root crops and clover also tell the tale to those who can read it ; swedes get 'finger-and-toe' and mangolds and sugar beet fail to grow up ; they start into growth but do not develop. Clover dies in patches during winter. If the crops show these signs, lime should be added to the soil ; the County Organiser can arrange for a test to be made to show what would be a suitable quantity to add.

The sowing of the barleys should be as early as is practicable consistent with the getting of a good tilth and the likelihood of steady continuous growth afterwards. It is very important that the plant should suffer no check once it has started growing, and the sowing date must be so chosen that the barley can grow steadily on without being held up by a long spell of bad weather. In the Southern and Eastern counties, February or early March is the time at which to aim, but elsewhere later times may be better. This is one of the most important items in the spring management, and it explains why barley after roots folded to sheep is often less satisfactory in quality than barley after a corn crop. Whenever the folding has thrown the sowing late it prejudices the quality.

Winter sowing sometimes gives even better results than early spring sowing, but one cannot rely on this. As yet no two-rowed winter variety is entirely hardy, and although in favourable conditions the result is successful—in Essex autumn-sown Plumage-Archer barley has in some cases given a 50 per cent. better cash return than spring-sown—nevertheless the risk of failure is always there. Search is still being made for good reliable winter varieties, including good six-rowed sorts that might replace the imported six-rowed barleys. As winter-sown barleys ripen early, they are, however, liable to damage by birds.

Coming back to sowing, the rate of seeding is not very important, and $2\frac{1}{2}$ bushels per acre usually gives as good a result as any other. The drills, however, should not be too wide ; the usual 7 inches between the rows is quite wide enough ; indeed, somewhat better yields, and equally good quality, were obtained at Sprowston by setting the drills only 4 inches apart. Widening the rows much beyond the usual width, however, has the effect of raising the nitrogen content of the grain which is undesirable.

Manuring if properly carried out raises the yield without injuring the quality ; indeed, it improves the valuation set on the grain by the buyer. The most important constituent is nitrogen, and the most useful quantity to add is 20 lb. per acre ; this corresponds to 1 cwt. sulphate of ammonia or $1\frac{1}{4}$ cwt. nitrate of soda given at the time of seeding. It used to be thought that nitrogenous manuring would injure the quality of the grain, and both agricultural experts and maltsters have in the past advised against it. There may have been some cause for anxiety in the old days with the old varieties, but with Plumage-Archer and Spratt-Archer there is little to fear ; they stand up to this quantity of manure and they commonly give in return an additional 5 or 6 bushels of grain with no loss of quality whatsoever. As between one nitrogeneous manure and another, there is little to choose : price and convenience in use are the deciding factors ; phosphatic and potassic manures, on the other hand, are more specialised in their value. There are many soils on which neither acts for barley, but on other soils they are needed. At the Norfolk centres superphosphate gave profitable increases in yield; at many of the other centres it did not. Barley needs phosphate more than wheat does, but the need for phosphate has hitherto been met by the large dressings given to the root crop which preceded it. With the reduction in the acreage under roots, however, these dressings will no longer be given, and then the need for supplying phosphate to the barley will become greater. Potassic fertilisers were effective on the light soils, but not on others.

In the harvesting and after-treatment of the crop it is of great importance to secure grain as dry as possible and of high germination capacity. Recently artificial drying of the grain has been practised on some farms; at present this is risky because the process cannot be fully controlled, and an excess of temperature may badly injure germination; it complicates things for the maltster, who in any case has probably to dry the grain again. Drying is of course quite safe for crops intended for feeding, but further experiment is necessary before it can be used generally for malting barley. It is, however, a promising line of development.

Effect of Season. The most important factors for the barley crop are the weather before sowing; the rainfall during March, April, May and June; the temperature during July; and (more important than either), the weather at harvest time.

The weather just before sowing determines the state of the seed bed and the date of sowing, and late sowing reduces yield, lowers the 1,000 corn weight and raises nitrogen content. Rainfall during March and April lowers yield considerably if it much exceeds the usual quantity, but drought during this period is also harmful. Rainfall during April, May and June lowers the nitrogen content of the grain and so tends to improve the valuation; on the other hand, drought during this period raises the nitrogen content and tends to lower the valuation. Temperatures above the average in July lower the yield and slightly raise the nitrogen content.

Thus, by the end of June the farmer should have a very fair idea of whether his barley is likely to be higher or lower in nitrogen than usual. If sowing has been delayed, if April, May and June have been drier than usual, other things being equal this may easily mean a lower valuation, unless indeed the harvest conditions are so good that his sample looks attractive in spite of its high nitrogen content. On the other hand, if the barley were sown early and went in well; if April, May and June have been moister than usual, the grain will contain less nitrogen than usual and so offers the possibility of making good malting barley.

It is, however, the conditions of harvesting that finally determine whether or not a crop of barley is either choice, or passable, or impossible malting material.

No pale ale brewer will buy "weathered" barley, or malt made from it and no brewer or maltster will buy any barley if its germinating capacity has been injured by either adverse weather during harvest or by the after-effects of stacking—always more serious when harvesting conditions are adverse.

When a large part of the home crop is injured as happens in exceptionally wet harvest seasons, maltsters and brewers naturally 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.* Nitrogen per cent. in dry grain.	*Barley.* 1,000 corn wt. gms.	*Malt.* Extract lb. per qr.	*Malt.* 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.