ROTHAMSTED RESEARCH

Report for 1935

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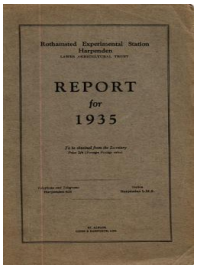

Experiments on Vegetable Crops

Rothamsted Research

Rothamsted Research (1936) *Experiments on Vegetable Crops ;* Report For 1935, pp 32 - 42 **- DOI: https://doi.org/10.23637/ERADOC-1-67**

About 14 per cent. of the samples in each season were autumn sown, and these usually graded better than the spring sown barleys. Thus for the two years :

In grades I, II, and III.	35 per cent. were autumn sown.
In grades IV, V.	12 per cent. ,, ,, ,,
In grades VI, VII.	8 per cent. ,, ,, ,,

Certain districts favoured autumn sowing much more than others, for example, in 1934, nearly half the barleys from Essex had been autumn sown and in 1935 nearly three-quarters.

In Norfolk barley now commonly follows sugar beet instead of swedes and turnips. Elsewhere, however, it still often follows turnips. Apparently it rarely follows potatoes.

Preceding Crops.

Barley after	1934 All counties.	1935 Norfolk.	1935 Others.	1935 All counties.	Both years total.
Cereals ..	90	22	69	91	181
Beet and Mangolds ..	38	58	39	97	135
Swedes, turnips, kale ..	19	10	30	40	59
Clover, peas, etc.	15	5	10	15	30
Potatoes ..	2	—	3	3	5
Bare and half fallow ..	3	—	1	1	4
Other crops ..	1	2	6	8	9

Much information was obtained in regard to the manuring of the barley. It is no longer a starvation crop. The experiments made by Rothamsted under the Institute of Brewing Research scheme during the last ten years showed clearly the advantage of suitable manuring when care was taken not to lodge the crop. This result has clearly passed into practice. Of the 270 samples sent in in 1935, 159 had received manure, 124 had received nitrogenous fertiliser, and no less than 61 of these had followed beet, turnips, or some other crop receiving dung, showing that the growers were prepared to give nitrogen even on land already in good condition. Some 51 crops had received compound fertilisers, which in 21 cases were the new high grade materials containing ammonium phosphate ; but many growers preferred to make their own mixtures.

EXPERIMENTS ON VEGETABLE CROPS

The importance of vegetable crops has considerably increased during recent years. Thus, for certain of the more important crops, the acreage returns for 1922 and 1934 are as follows :

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Crop.	Acreage. 1922	1934	Increase per cent.
Carrots	14084	16432	+16
Onions	3557	2099	−59
Cabbage	27954	36981	+32
Brussels Sprouts	14951	34048	+128
Cauliflowers and Broccoli ..	10475	20107	+92
Celery	5282	7510	+42
Rhubarb	5718	8233	+44
Green beans	12907	16833	+30
Green peas	50894	74363	+45

Thus, with the exception of onions, there has been a substantial increase in the acreage planted with vegetables in recent years. The value per acre of the vegetable crops is also high ; the actual prices realised depend greatly on quality, supplies, and the effect of weather on demand.

An estimate of the annual supplies and values of vegetables for human consumption has recently been made* from which may be derived the following data relating to the years 1930-32 :

Crop.	Av. Yield per acre, tons.	Gross Value† per acre, £
Outdoor Cabbage lettuce	8	75
Celery	10	60
Broccoli and Cauliflower ..	8	71
Spring Cabbage and Cabbage Greens	7	51
Autumn Cabbage	9	40
Sprouts	3.7	53
Green Peas	2.2	30
Ripe Onions	7	39
Topped Carrots	11.7	50
Red Beet	12	48

† Freight and market charges to be deducted.

Prices also have been well maintained as compared with general farm produce, thus the agricultural index of all vegetables in 1934 was 143 (1911-13=100) whereas the general index of agricultural produce for the same year was 114.

The first experiments on vegetable crops conducted from Rothamsted, using the new technique, began in 1931, on winter cabbages, Brussels sprouts, and first early potatoes. There have now been put on record in the Station Reports some fifty experiments on vegetable crops carried out at Rothamsted, Woburn, outside centres, and by local workers operating general schemes of investigation administered from Rothamsted. The rapid expansion of this work was rendered possible by the investigation on the value of dried poultry manure put in hand by the Ministry of Agriculture and controlled from this station. It was decided to test this manure as

* " Min. Agric. Economic Series." No. 25, 1935. P. 172.

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far as possible on market garden crops since its most promising outlet would probably be for small scale intensive cultivation.

Experience has shown that experiments with vegetable crops, although in most cases rather more exacting than with farm crops, offer no insuperable difficulties. As will be seen later, standard errors tend to be a little higher than the average of large scale root crops, but none the less a considerable number of statistically significant fertiliser effects will be found in the tables that follow. On the other hand certain crops have shown very small or even negative effects. Early potatoes, carrots, onions, strawberries have all been disappointing in this respect. The experiments are, however, only a first approach to a wide subject and many more will be required to obtain an adequate view of the fertiliser responses of vegetable crops.

More has been done with Brussels sprouts than with any other crop, so that the results of the experiments on the growth of this plant will be set out first. There are thirteen experiments with sprouts on record, but one at Rothamsted was practically a failure owing to damage by wood pigeons. Of the twelve good experiments, all show the effect of nitrogen as sulphate of ammonia usually at several rates of dressing, most of them test dried poultry manure and superphosphate and two test sulphate of potash. There are figures for the individual pickings, usually carried out on three occasions, but sometimes on four, and in most cases there are figures relating to the proportion of blown or unsaleable sprouts. The mean yields of total saleable sprouts and the increases for the various nutrients are set out in Table I. In this and succeeding Tables the single dressings of sulphate of ammonia (N_1) and dried poultry manure (M_1) were usually at the rate of 0.3-0.4 cwt. N per acre, the double dressings N_2 and M_2 being 0.6-0.8 cwt. N. Superphosphate (P) was at the rate of 0.4-0.6 cwt. P_2O_5 per acre ; while sulphate of potash K_1 was at the rate of 1.0 cwt. K_2O per acre, K_2 being 1.5-2.0 cwt. K_2O.

The mean yields ranged from 22.4 to 90.8 cwt. of saleable sprouts per acre with a general mean of 44.3 cwt. The most marked manurial effect was given by nitrogen. For the years 1933 and 1934 there are sufficient centres to make an estimate of the average effect of this nutrient in the form of sulphate of ammonia and poultry manure, the results being brought to a common basis of 0.6 cwt. N per acre. The figures are :—

Total Saleable Sprouts, cwt. per acre.

Mean increase for 0.6 cwt. N per acre.

	No. of Experiments	Sulphate of Ammonia.	Poultry Manure.
1933.. ..	6	+1.65	+2.74
1934.. ..	4	+12.95	+7.46

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TABLE I.

Brussels Sprouts. Total saleable Sprouts, cwt. per acre.

Year.	Centre No.	Soil.	Mean Yield.	Increases for N_1	N_2	M_1	M_2	P	K_1	K_2	Standard Error.
1931	1	Light chalk ..	49.3	−2.4	−0.9	+5.8	—	—	—	—	±3.44
1933	2	Clay loam ..	29.8	−0.3(1)	−1.4(1)	—	+1.2	+2.2	—	—	±1.24
1933	3	Sandy ..	40.4	—	+9.0	—	+4.8	−1.9	—	—	±1.89
1933	4	Chalk loam ..	22.4	−3.0	−5.7	—	−1.7	—	—	—	±1.84
1933	5	Poor sand ..	24.7	+1.2	—	+0.4	—	+0.3	—	—	±1.44
1933	6	Boulder clay..	40.3	—	+2.0	—	+8.2	+10.3	—	—	±1.09
1933	7	Medium-heavy	38.3	+1.1	—	—	—	−0.2	—	+9.7	±1.28
1934	8	Clay loam ..	90.8	+3.9	+10.2	+9.0	+8.2	—	—	—	±2.60
1934	9	Silty gravel ..	63.9	+11.6	+16.3	+4.4	+7.6	—	—	—	±1.53
1934	10	Gravel loam	43.2	+13.1	+20.9	+3.7	+8.2	—	—	—	±1.00
1934	11	Gravel loam	58.7	—	+10.2	—	—	−3.7	+1.6(2)	+4.2(2)	±2.10
1935	12	Silty loam ..	29.8	+3.9	+2.4	+3.2	+4.8	—	—	—	±2.95

(1) ±1.53. (2) ±2.56.

Responses were much greater in 1934 than in 1933, and in the more favourable season there is evidence that sulphate of ammonia was more effective than poultry manure providing the same amount of nitrogen. Thus at centres 9 (Wyboston, Bedfordshire), and 10 (St. Albans), the difference between sulphate of ammonia and poultry manure was significant.

The action of superphosphate was less general than that of nitrogen and only at one centre, No. 6 (Honeydon, Bedfordshire), on a boulder clay soil was its effect really important. In this experiment, however, 3 cwt. of superphosphate increased the yield by no less than 10.3 cwt., and it is probable that the superiority of poultry manure over sulphate of ammonia shown at this centre was due in part to the phosphate that the organic manure provided. There is some evidence of a beneficial effect of superphosphate on the heavy soil at centre 2 (Rothamsted).

Potash was tried at two centres only. At centre 7 (London Colney, Herts.) it gave the large increase of 9.7 cwt. for 3 cwt. of the fertiliser. In the following year at the same centre a smaller but nevertheless significant effect was obtained.

Earliness is a valuable feature in growing market garden crops and it is therefore important to trace the fertiliser effects through the successive pickings whose sum goes to make the total discussed above. The results are collected in Table II, which presents those centres at which the fertiliser responses were strongly defined. The total response in saleable sprouts is taken as 100 and the respective contributions of the separate pickings are expressed on this basis. The figures refer to the higher level of nutrient in each case.

TABLE II.

Saleable Sprouts.

Fertiliser responses in successive pickings.
Total response = 100.

Centre No.	Nitrogen. Pickings. 1st	2nd	3rd	Poultry Manure. Pickings. 1st	2nd	3rd	4th	Phosphate Pickings. 1st	2nd	3rd	4th	Potash Pickings. 1st	2nd	3rd	4th
1				+91	+31	−22									
2								+88	−19	+13	+18				
3	+77	+13	+10	+80	+14	+6									
6				+19	+35	+29	+17	+39	+34	+20	+7				
7												+28	+43	+20	+9
8	+ 8	+80	+12	−9	+97	+12									
9	+20	+58	+22	+30	+40	+30									
10	+82	+7	+11	+60	+30	+10									
11	+51	+33	+16									+196	−60	−36	

In the above table there are 15 results showing three or more pickings. In nine instances the response in the first picking is the greatest, and in six of them over three-quarters of the total effect is to be found in the first picking. In the six experiments in which the first picking is not greatest the second picking is the largest. In no case is there more than 30 per cent. of the total response in the third picking, or 18 per cent. in the fourth. In several of the experiments the predominance of the fertiliser effect in the first picking

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is in itself significant, e.g., at centre 2 (Rothamsted) and 11, (London Colney). The figures show that when a nutrient is effective, its action tends to be strongest in the early part of the season. Phosphate and potash both gave earlier crops at each of the two centres where they acted. Sulphate of ammonia and poultry manure, on the other hand, did not appear to hasten growth.

The experiments give some information on the relationship of fertiliser action and grade of produce for in most of them the weight of " blown " or unsaleable sprouts was ascertained, and in some of them the saleable sprouts were themselves graded. The effects of the nitrogenous manures on the weight of " blown " or unsaleable sprouts and their percentage of the total crop, including blown are given in Table III.

TABLE III.

Effects of nitrogenous manures on blown (or unsaleable) Sprouts expressed as increases over controls.

Centre No.	Increases cwt. per acre				Per cent. of total crop.			
	N_1	N_2	M_1	M_2	N_1	N_2	M_1	M_2
1	+3.0	+4.5	+6.5	—	+4.5	+5.5	+5.0	—
2	+0.2	+0.2	—	+1.1	+0.3	+1.3	—	+1.6
3	—	+2.1	—	+0.9	—	+1.6	—	+0.6
4	−0.5	−1.0	—	+0.5	−1.1	+2.7	—	+2.4
5	+2.0	—	+0.8	—	+4.3	—	+1.6	—
6	—	+1.2	—	+0.6	—	+1.5	—	−1.7
7	+0.5	—	—	—	+0.6	—	—	—
9	+1.1	+1.9	+1.3	+2.0	+1.0	+1.7	+1.6	+2.7
10	+0.8	+1.2	+0.2	+0.4	−1.7	−2.4	−0.7	−1.3

In eight of the nine experiments with sulphate of ammonia the actual weight of unsaleable sprouts per acre was increased, by an average of 1.4 cwt. per 3 cwt. sulphate of ammonia. The percentage of unsaleable produced was also increased in eight out of the nine experiments. At centre 10 (Oaklands), St. Albans, the effect of nitrogen on yield was so large that although the actual quantity of blown sprouts was increased, the percentage was smaller. Dried poultry manure behaved similarly to sulphate of ammonia at most centres. The effect of superphosphate was in general small, but at centre 6 (Honeydon, Bedfordshire), the unsaleable sprouts were increased by 1.6 cwt, while the percentage unsaleable was decreased by 0.6 per cent. In one experiment with potash the actual yield of unsaleable sprouts was increased by 1.3 cwt. but the percentage fell by 1.1. per cent. Taking the results as a whole, the effect of manures appears to be slightly to increase the actual weight of blown or unsaleable sprouts, but when the crop responds well to manures the final result is that the proportion of unsaleable produce is reduced.

Six experiments, set out in summary form in Table IV, are on record dealing with cabbages and Broccoli.

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TABLE IV

Cabbages and Broccoli

Effect of Nitrogen, Phosphate and Potash

Weights or numbers per acre

Crop	Centre No.	Soil	Mean Yield Tons or Numbers	Increase for N_1	N_2	M_1	M_2	P_1	P_2	K†	Standard Error
Spring Cabbage	1	Light	13.6	+1.19	—	—	—	—	—	+0.43	±0.496
Spring Cabbage	2	Sandy	6.0	+1.17	+2.87	+0.65	+0.96	—	—	—	±0.838
Savoys	3	Medium	20.6	—	+7.42	—	+3.94	—	—	—	±1.270
Broccoli Heads	4	Shale loam	1.56	—	+0.22	—	+0.16[1]	−0.03	—	—	±0.097
Broccoli Outsides	4	Shale loam	7.28	—	+0.68	—	+0.48[2]	+0.02	—	—	±0.437
Number	4	Shale loam	5,838	—	+303	—	+100[3]	−49	—	—	±133
Winter Cabbage	5	Sandy	5,462	+510	+1,245	—	—	—	—	—	±350
Winter Cabbage	6	Sandy	2,727	—	—	—	—	+281	+360	—	±259
Wt. per Cabbage, lb.	—	—	1.25	—	—	—	—	—	0.0	−0.02	±0.038

([1]) S.E. ±0.119. ([2]) S.E. ±0.536. ([3]) S.E. ±163.

†K stands for 1·3 cwt. K_2O per acre, as Sulphate of Potash.

Spring cabbages respond well to nitrogen as sulphate of ammonia at centre 1 (Avoncroft, Evesham) and 2 (Steppingley, Bedfordshire). At Steppingley, there is some indication that sulphate of ammonia was more effective than dried poultry manure but the difference does not reach significance. Savoy cabbages at centre 3 (Newport, Salop) show strong nitrogen responses and here the difference between sulphate of ammonia and poultry manure is statistically significant. At centre 4 (Dartington Hall, Devon) sulphate of ammonia increased the yield of broccoli heads and also the number per acre, the effect of dried poultry manure was smaller. At centre 5 (Potton, Beds.) nitrate of soda, applied to the previous early potatoes in this case, significantly increased the number of cabbages fit to cut on December 7th. There were no marked effects of phosphate or potash in the above experiments, and so far as they go they support the view that quick-acting nitrogen is likely to prove the most useful fertiliser for this type of crop.

The results for first early potatoes and root crops have been summarised in Table V. The figures for first early potatoes have been derived from a single farm, Potton, Beds., in 1931 and 1934. Experiments 1 and 2 were without dung; experiment 3 received dung. The crop was lifted early and proved very unresponsive in all cases. It is known from other experiments that first earlies left to stand till later in the season respond better to manures. Thus a crop at Little Downham, Ely, on fenland soil cut down by frost on May 17th, 1935, and left to stand till July 30th, gave an increase of 3.03 tons for 5 cwt. of sulphate of ammonia and 1.43 tons for 3 cwt. superphosphate per acre, both significant.

With the exception of a significant increase for poultry manure at centre 4 (Wye) and an improvement in the proportion of first grade bulbs at 7 (Swanley), onions have shown little response to

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nitrogen or phosphate in these experiments. Carrots have been surprisingly unresponsive in the roots; sulphate of ammonia and poultry manure generally reduced the yield and at centre 9 (Chittoe, Wilts.), the reduction was almost significant. Sulphate of ammonia increased the tops significantly at 10 (Woburn) and worked in the same direction at a second experiment at Woburn, 9. Plant number is significantly reduced by sulphate of ammonia in experiment 10. The very large yield in experiment 8 was the result of a dunged bare fallow in the previous year.

Red beet shows a good and significant response to sulphate of ammonia but less to dried poultry manure. The difference between the two manures although in the usual direction is not significant.

TABLE V
First Early Potatoes and Root Crops
Effect of Fertilisers

Centre No.	Soil	Mean Yield	Increase for N_1	N_2	M_1	M_2	P_1	P_2	K_1	Standard Error
First Early Potatoes		Tons								
1	Sandy	4.71	+0.14	+0.32	—	—	—	—	—	±0.170
2	Sandy	4.02	—	—	—	—	+0.25	−0.21	—	±0.175
3	Sandy	3.78	—	—	—	—	+0.14	—	+0.06	±0.124
Onions										
4	Chalk loam	7.64	—	+0.09	—	+0.86	+0.11	—	—	±0.332
5	Light	11.23	—	−0.06	—	+0.11	—	—	—	±0.452
6	Light	10.15	—	+0.03	—	+0.30	—	—	—	±0.407
7	Sandy	6.07	—	−0.25	—	+0.79	—	—	—	±0.691
		Per cent. 1st grade								
		66.4	—	+6.9	—	+6.0	—	—	—	±3.03
Carrots										
8	Sandy	Tons								
	roots	21.10	−1.20	−0.54	−0.20	−0.32	—	—	—	±0.722
	tops	9.23	+0.23	+0.94	−0.41	+0.57	—	—	—	±0.551
9	Sandy roots	10.52	—	−1.02	—	−0.77	—	—	—	±0.491
10	Sandy									
	roots	8.97	—	−0.63	—	+0.16	—	—	—	±0.421
	tops	3.42	—	+0.62	—	+0.29	—	—	—	±0.199
	Plant No.	Thous.								
		106.1	—	−5.0	—	−1.4	—	—	—	±1.422
Red Beet		Tons								
11	Loam	14.72	—	+2.10	—	+0.88	—	—	—	±0.800

Turning now to leguminous crops there have been five experiments on peas, one on French beans, and one on Runner beans. The results are summarised in Table VI.

TABLE VI
Leguminous Crops.

Year	Centre No.	Soil	Mean Yield per acre	Increase for N	M	P	K	Standard Error
Peas								
1933 ..	1	Sandy gravel	Peas cwt. 34.3	+3.50	—	−0.70	−2.45	±1.00
1934 ..	2	Light loam	,, ,, 77.0	+4.0	−1.2	—	—	±2.35
1934 ..	3	Sandy clay	,, ,, 46.8	−1.2	+5.4	—	—	±4.44
1934 ..	4	Silty gravel	,, ,, 93.9	−3.6	−4.1	—	—	±1.84
1934 ..			Haulm ,, 76.5	+2.9	−2.9	—	—	±1.37
1935 ..	5	Medium Loam	Peas ,, 96.7	−9.9	−4.3	—	—	±5.80
French Beans								
1935 ..	6	Sandy	Beans cwt. 45.1	+0.7	+9.4	—	—	±3.27
			Haulm ,, 61.6	+12.2	+29.8	—	—	±4.64
Runner Beans								
1935 ..	7	Alluvium	Beans ,, 39.7	+4.7	+5.0	—	—	±5.88

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Peas have given very different results at the different centres. No. 1 (Stanford, Beds.) gave a significant response to quick-acting nitrogen, and the average response at centre 2 (Evesham) to sulphate of ammonia both in presence and in absence of poultry manure was $+4.9 \pm 1.66$ and therefore significant. On the other hand nitrogen in general reduced the yield significantly at centre 4 (Langford, Beds.), the effect was in the same direction also at 5 (Norton, Yorks.).

On French beans at 6 (Godalming) there was some indication of a response to poultry manure but none to sulphate of ammonia. Both manures give marked increases in haulm at this centre and in this respect poultry manure was significantly more effective than sulphate of ammonia. There were no effects on runner beans.

In experiment 1, phosphate in the form of basic slag had no effect on peas at Stanford, whereas potash significantly depressed the crop—an unexpected result on a sandy soil.

Experiments on miscellaneous horticultural crops have included lettuces, strawberries, celery, and apple stocks grown for vegetative reproduction. None of the manures tried had any effect on the number of lettuces fit to cut in spring ; in fact, their action was slightly depressing but not to a statistically significant extent. Manures applied to the parent apple stock in mid-June had no effect in the value of the offshoots, although sulphate of ammonia significantly reduced the value of the roots borne by the offshoots. It is possible that earlier application of fertilisers might have given better results.

Sulphate of ammonia was compared with poultry manure on strawberries and while the quick-acting nitrogen tended to depress the weight of total crop, the organic manure tended slightly to increase it, the mean difference being almost significant. Effects in the same direction were observed in the percentage of first grade fruits so that the final result was :

LONG ASHTON, 1934

First Grade Strawberries cwt. per acre	
No nitrogen	5.91
Sulphate of Ammonia ..	4.30
Dried Poultry Manure ..	6.72

Celery proved to be a more responsive crop. The experiment at Mepal, Isle of Ely, on a light fenland soil in presence of farmyard manure showed definite increases in yield for superphosphate, sulphate of potash, and agricultural salt. Potash and salt also gave a significant improvement in the grading results. The figures relating to the above crops are given in Table VII.

The experiments summarised above give some information on the question of the relative precision of experiments on the vegetable crops as compared with ordinary farm crops. The average values for the standard error of a single plot expressed as a percentage of the mean yield have been determined by Yates*, for potatoes and sugar beet in recent randomised block and Latin square experiments at the outside centres, and these figures are given below together with general averages from all available Rothamsted experiments for swedes, mangolds and Kale.

*F. Yates, Suppt. Jn. Roy. Stat. Soc., 1935, 11p. 214.

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TABLE VII

Miscellaneous Crops

Centre No.	Soil	Mean Yield per acre	N_1	N_2	M_1	M_2	P_1	P_2	K_1	K_2	Standard Error
Lettuces											
1	Medium Loam	No. thous. 33.3	−6.0	−5.9	—	—	−2.3	−3.8	−1.5	−3.7	±3.28
Apple Stocks											
2	Clay with flints	Value per stock, pence, 14.65	—	−0.48	—	—	+0.36	—	—	+0.10	±0.735
		Value of roots, pence, 0.92	—	−0.27	—	—	0.0	—	—	+0.08	±0.094
Strawberries											
3	Medium Loam	Total cwt., 17.9	−2.8	−4.6	+1.5	+1.2	—	—	—	—	±2.65
		First grade %30.7	−4.90	−4.61	+3.09	+0.74	—	—	—	—	±2.61
Celery											
4	Light Fen	Total tons, 8.32	Salt +0.43	—	—	—	—	+0.34	—	+0.89	±0.144
		Two Highest grades, %61.6	+3.9	—	—	—	—	−1.0	—	+4.0	±2.42

STANDARD ERRORS PER PLOT

Average Values as percentage of Mean Yields

	No. of Expts.	
Potatoes 1927-1933 Latin Square ..	56	6.8
,, ,, ,, Randomised blocks	22	9.2
Sugar Beet Roots Latin Squares ..	28	6.1
Randomised blocks	15	7.9
Swedes. Mean of all plot arrangements	8	6.9
Mangolds ,, ,, ,,	6	8.2
Kale ,, ,, ,,	18	7.7

These values are rather uniform and it appears that for ordinary farm roots standard errors of about 7 to 8 per cent. may be regarded as normal.

In Table VIII below are collected the actual and percentage standard errors per plot of the vegetable crops discussed above.

TABLE VIII

Standard Errors of Experiments on Vegetable Crops, 1931-1935

(A) Full Sized Plots.

Crop	No. of Expts.	Standard Error per plot.	
		Actual per acre	Per cent of mean
Brussels Sprouts, total crop cwt.	11	3.83	10.1
Winter cabbages. No. fit to cut	2	518	13.2
Broccoli heads. Tons	1	0.29	18.6
Spring cabbages. Tons ..	2	1.04	12.1
Savoy cabbages. Tons ..	1	2.00	9.7
First Early potatoes. Tons ..	3	0.27	6.6
Carrots. Tons	3	1.08	8.7
Onions. Tons	4	0.92	11.9
Peas. Cwt.	4	4.02	7.5
Runner beans. Cwt.	1	11.76	29.6
Celery. Tons	1	0.35	4.3

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(B) Microplots (1/145 acre or less).

Crop	No. of Expts.	Standard Error per plot	
		Actual per acre	Per cent of mean
Tomatoes. Total crop, tons ..	2	2.96	5.6
Apple stocks. Value, pence per stock	1	2.94	20.0
Lettuce. No. fit to cut, thous.	1	9.86	29.6
Pyrethrum. Dry flower heads, cwt.	2	0.92	15.6
Peas. Cwt.	1	8.20	8.5
French beans. Cwt.	1	4.62	10.2
Red beet. Tons	1	1.13	7.6
Strawberries. Cwt.	1	5.3	29.6

The most reliable value in this table is that for sprouts, which rests on 11 experiments. With a mean standard error of 10.1 per cent., this crop is slightly more variable than ordinary farm roots, possibly owing to the much smaller plant population per plot and the element of judgment entering into the several pickings. Nevertheless, a standard error of this size would be regarded as quite normal for certain farm crops such as cereals. Among other crops, broccoli and runner beans stand out as rather variable, while early potatoes, carrots, and peas have given values quite in keeping with those derived from ordinary potatoes and roots.

As might be expected the microplots show somewhat larger errors. The actual magnitude of the standard errors is the important figure for estimating the size, or cash value, of a difference that is likely to be detected by experiments of the kind under review. A well-designed experiment set out as a 6 by 6 Latin square will detect, as statistically significant, differences between treatment means of almost three-quarters of the standard error per plot. Smaller arrangements are less precise. The size and value of differences that would be judged significant in experiments of the precision of the Latin square are :—

Significant Differences per Acre

	Actual size. Cwt.	Approximate cash value. Shillings
Brussels Sprouts	2.7	34
Carrots	15	97
Onions	13	80
Peas	2.8	44

It is clear that the value of produce represented by a significant difference is quite large in relation to any probable expenditure on manures, so that with these high value crops the most efficient arrangements and fullest replication possible should be aimed at, so that treatment effects that are actually of high cash value and well worth having shall not fail to reach the level of statistical significance.

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