THE MANURING OF SUGAR BEET

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In a previous paper (Boyd, Garner & Haines, 1957) the fertilizer requirements of sugar beet were determined from the results of over 300 experiments carried out in the years 1934–49. If the best use is to be made of the experimental evidence, the adviser also needs to have some idea of what manures growers actually apply to their crops. Such information is provided by the Survey of Fertilizer Practice, which has been carried out in a substantial number of English counties by the staff of the N.A.A.S. Provincial Soil Chemists with the co-operation of the Statistics Department, Rothamsted.

From examination of the experimental results it was concluded that for most beet-growing soils, other than fen peats, the optimal dressings of nitrogen and potash fertilizers in the absence of farmyard manure are unlikely to be less than 1·0 cwt. N and 1·5 cwt. K_2O per acre. Since these rates are above the highest levels tested in the experiments, estimates of the optimal dressing cannot be made with confidence, and it is possible that the optima are as high as 1·2 cwt. N and 2·0 cwt. K_2O per acre; however, the extra profit to be derived from these higher dressings is likely to be small in relation to costs of application. Differences in fertilizer requirements between factory areas were not sufficiently large to warrant differential recommendation for N and K, except that on the Chalky Boulder Clay soils of the Felsted, Bury and Ipswich areas potash was ineffective or even depressed yield. Phosphate responses were generally small, especially in the east and west midlands and in Yorkshire. The experiments form a striking demonstration of the value of salt for sugar beet in almost all districts whether or not potash is also applied.

The Survey of Fertilizer Practice provides data on the manuring of sugar beet in four districts surveyed in 1954 and four others surveyed in 1952; most of these districts have been surveyed several times since 1942, when fertilizer surveys were first started. The results for each district are based on a random sample of 50–60 farms, not all of which would necessarily be growing sugar beet. A brief description of these districts is given in Table 1.

The percentage of the beet acreage receiving farmyard manure and fertilizers in each surveyed district, and the average rates of application on the dressed acreage, are given in Table 2.

Table 1. *Beet-growing districts included in survey of fertilizer practice*

Year of survey	No. of beet fields surveyed	County	Part of county	Factory area
1952	66	Shropshire	East and south-east	Allscott
1952	74	Norfolk	North-west	King's Lynn
1952	48	Essex	North-west: north of Stane Street and west of Braintree–Haverhill main road	Felsted
1952	74	Lincs (Lindsey)	North-west	Brigg
1954	32	Yorks (W. Riding)	East of line Leeds–Barnsley–Sheffield	Selby
1954	13	Northants	North-east	Peterborough
1954	75	East Suffolk	Excluding area to east of Ipswich–Bungay main road (A12, A144)	Bury and Ipswich
1954	83	Isle of Ely	Peat and silt soils only	Ely

In the West Riding and east Shropshire, where farmyard manure is relatively plentiful, and in east Suffolk, where few potatoes are grown, over half the beet acreage was dunged. Even in north-west Norfolk, which is on the whole thinly stocked, a third of the acreage was dunged, about the same fraction as in north-west Essex where the bulk of supplies are used on potatoes. In the Isle of Ely, sugar beet frequently follows a very heavily manured crop of potatoes or celery and is then grown without further farmyard manure and with little fertilizer; in the Fens, generally speaking, the farmyard manure is reserved for crops other than beet.

Calculations based on all fields with farmyard manure and all fields without farmyard manure (i.e. not balanced as between farms) show that, in every district, growers who have farmyard manure available for beet tend on the average to use rather

less of each nutrient on their beet than those who apply fertilizers alone. However, examination of the data for fifty-one farms which had fields of beet with and without farmyard manure reveals almost exactly uniform treatment for the two groups of fields (all quantities per acre):

Fields with F.Y.M.				Fields without F.Y.M.		
tons F.Y.M.	cwt. N	cwt. P_2O_5	cwt. K_2O	cwt. N	cwt. P_2O_5	cwt. K_2O
13·3	0·92	0·83	1·12	0·92	0·84	1·17

Beet receives rather smaller dressings of fertilizers on the silt soils of the Isle of Ely than in the other districts quoted in Table 2. The average dressing on the peat soils was markedly less for nitrogen and potash and somewhat less for phosphate than in these other districts; nevertheless, it is remarkable, in view of the experimental results for peat soils, to find that all but 10% of the beet on these soils received nitrogen at an average rate of 0·51 cwt. N per acre. At the rate of dressing used in the experiments (0·8 cwt. N per acre) the net return on plots with phosphate and potash alone was greater by over 60*s*. per acre than that on plots receiving the complete fertilizer. At the lower rates of application normally adopted the loss will be much less than this, but it seems unlikely that growers can receive any return from the use of nitrogen on true peat soils; on worn-out peat soils, of course, the nitrogen responses are probably much closer to those of mineral soils.

Excepting on the peat and silt soils, practically the whole beet acreage received a complete fertilizer; together with potatoes, sugar beet can be regarded as the most consistently manured crop in the country. Again excepting the Isle of Ely, the average rates of application of fertilizers shown in Table 2 are high, although not uniformly so. The average rates for N have the range 0·7–1·3 cwt. per acre, for P_2O_5 0·7–1·3 cwt. per acre and for K_2O 1·0–1·6 cwt. per acre. It follows from the widespread use of compound fertilizers, and the substantial uniformity of the plant food ratios in these compounds, that districts which apply large amounts of one nutrient tend to be liberal with the other nutrients also: this is particularly marked for north-west Lindsey. It is remarkable to find that growers in north-west Essex and east Suffolk on Chalky Boulder Clay soils are using so much potash, although it is true that north-west Essex is the only district using more N than K_2O per acre. If the experiments are to be believed, this potash is entirely wasted, and may even cause some depression of yield.

In comparing growers' practice with the recommendations derived from the experiments, some account must be taken of the nutrients contained in the substantial amount of farmyard manure used. The total effective nutrients applied to beet are shown in Table 3, the quantities being the unweighted means for six districts (i.e. excluding north-east Northants, which is poorly represented, and the Isle of Ely). The effective amounts of N, P_2O_5 and K_2O in farmyard manure are calculated from the equivalents given by Boyd & Lessells (1954), who reckoned that in the year of application 10 tons farmyard manure were on the average equivalent to 0·2 cwt. N, 0·4 cwt. P_2O_5 and 0·6 cwt K_2O per acre.

Table 2. *Use of fertilizers and farmyard manure for beet*

Year	County	No. of fields	Percentage of acreage dressed F.Y.M.	N	P	K	Rates per acre on dressed acreage: tons F.Y.M.	cwt. N	cwt. P_2O_5	cwt. K_2O
1952	E. Shropshire	66	63	100	100	99	14·2	1·00	0·91	1·29
	N.W. Norfolk	74	32	99	99	99	11·2	0·79	0·70	1·33
	N.W. Essex	48	31	100	99	97	12·9	1·11	0·80	0·99
	Lindsey	74	21	100	99	100	12·1	1·26	1·03	1·65
1954	W. Riding	32	56	100	100	100	15·6	0·74	0·72	1·11
	N.E. Northants	13	62	100	100	100	15·0	0·71	0·71	1·02
	E. Suffolk	75	61	100	97	94	12·5	0·88	0·77	1·03
	Isle of Ely — Silt soils	28	11	93	93	93	16·2	0·66	0·78	0·81
	Isle of Ely — Peat soils	52	15	90	90	83		0·51	0·60	0·70

Table 3. *Comparison of nutrients applied to beet with recommendation from experiments*

	Quantities per acre: cwt. N	cwt. P_2O_5	cwt. K_2O
Fertilizers	0·96	0·82	1·23
Farmyard manure	0·11	0·22	0·33
Total effective nutrients	1·07	1·04	1·56
Recommended dressing	1·0	0·5	1·5

The table shows that if allowance is made for the farmyard manure applied, growers' use of nitrogen and potash agrees closely with the recommendations derived from experiment. The optimum dressing of potash would, of course, be much less where salt was also used; in this case it would be sufficient on most,

though not all, soils to apply only sufficient potash to ensure that following crops of the rotation did not go short.

For phosphate, the amounts normally applied are obviously excessive. The recommended dressing in Table 3 is the maximum quantity which is likely to be profitable at those levels of nitrogen and potash. Even this small quantity may well be an overestimate of the present-day requirement of phosphate for sugar beet, since no allowance has been made for some selection of the experimental sites in the direction of phosphate deficiency, or for the considerable rise in phosphate consumption both during and since the period covered by the experiments. It is certain that profit from the use of phosphate fertilizer is likely to be very small compared with that from nitrogen and potash or salt. In all districts it should be unnecessary to apply phosphate in addition to farmyard manure, or after a well-manured root or green crop. In several factory areas (Colwick, Kelham, Brigg and Selby) the use of phosphate at the rate of 1·0 cwt. per acre, which is close to the current average rate of dressing, gave substantial losses, the average net loss being about 40*s.* per acre. If beet were the only crop in the rotation to receive phosphate the use of substantial quantities on this crop would seem more reasonable; in fact, there is rarely any question of 'cashing-in' on residual values, since it is now normal practice for most of the subsequent crops of the rotation to receive a fresh application of phosphate. It seems probable that fully half of the total amount applied to sugar beet gives little or no return, and on the total sugar-beet acreage there may well be an average loss of £1 per acre per annum. There are at present few compound fertilizers in general use which permit the application of large quantities of nitrogen and potash but only a little phosphate, whilst nitrate of potash is used in only a small way on horticultural crops. Until such a compound fertilizer becomes generally available a satisfactory alternative is provided by using a high-K compound fertilizer, the nitrogen content of which can easily be supplemented by the further application of a straight nitrogen fertilizer.

Whilst sugar beet appears to be very consistently manured if we take averages over districts, there is a very wide range of manurial practice from farm to farm, except in so far as almost all fields are dressed to some extent. The range is shown for the mean of the districts in Table 4, excluding the Isle of Ely, whose fertilizer practice is rather different from that of the other districts, and north-east Northants, from which the number of sampled fields of beet is small. The percentages shown are the straight means of the individual percentages for the six districts concerned. Thus each nutrient covers the whole of the range from very small or zero dressings to large amounts exceeding 2·0 cwt. per acre. Nitrogen dressings are the most consistent with almost two-thirds of the crops receiving between 0·6 and 1·2 cwt. N per acre. It is surprising, however, to find that about one-fifth of the crop in these districts received under 0·6 cwt. N per acre. The range of dressings is particularly wide for potash, and this seems to be only to a small extent associated with the use of salt and farmyard manure.

Table 4. *Spread of individual fertilizer dressings of* 369 *fields in six districts*, 1952–4

	Nil	0·01–0·20	0·21–0·40	0·41–0·60	0·61–0·80	0·81–1·00	1·01–1·20	1·21–1·40	1·41–1·60	1·61–1·80	1·81–2·00	2·01+	All
Nitrogen (cwt. N per acre)	3	1	7	11	22	23	18	10	4	2	2	0·3	100
Phosphate (cwt. P_2O_5 per acre)	2	0·5	6	21	27	22	13	4	2	1	1	0·5	100
Potash (cwt. K_2O per acre)	3	0	2	12	9	11	23	9	15	7	3	6	100

Table 5. *Average fertilizer dressings on fields with and without salt* (*amounts in cwt.* N, P_2O_5 *and* K_2O *per acre*)

	With salt				Without salt			
	No. of fields	N	P_2O_5	K_2O	No. of fields	N	P_2O_5	K_2O
West Riding	21	0·65	0·66	0·89	44	0·80	0·77	1·17
East Shropshire	76	1·00	0·97	1·34	49	0·84	0·89	1·18

The experimental results appear to demonstrate conclusively the value of salt for beet, but its use has not become general and in only a few counties is its use widespread. In the eastern and east midland counties surveyed the percentage of the crop dressed with salt varies from 0 to 25% with an average of 6%. However, one-half to two-thirds of the beet in east Shropshire and one-quarter of the beet in the West Riding received salt; such information as there is on changes in practice suggests a slight decline. The average rate of application is about 5 cwt. per acre, with a range of $2\frac{1}{2}$–$7\frac{1}{2}$ cwt. per acre. Like the excessive dressings of phosphate referred to above, the failure to use salt is no doubt

closely bound up with growers' strong preference for compound fertilizers. Possibly the new compounds containing salt may help to make salt more widely used.

The extent to which fertilizer practice is modified when salt is used is shown in Table 5 for the West Riding, surveyed in 1951 and 1954, and for east Shropshire, surveyed in 1951 and 1952, these being the only surveyed counties in which the use of salt was widespread. Almost all fields received all the fertilizer nutrients whether or not salt was applied. Bearing in mind that this comparison is not being made between fields on the same farms, there is no evidence of any major difference in fertilizer practice as between fields dressed with salt and those not dressed.

SUMMARY

Information on how growers actually manure their crops is available from the Survey of Fertilizer Practice, carried out by the Provincial Soil Chemists of the N.A.A.S., in collaboration with Rothamsted. These data indicate that, taking into account the nutrients in farmyard manure, the average amounts of nitrogen and potash applied are not far from the optimal amounts suggested by experiment, whilst phosphate dressings are on the average at least double requirements. This may be due in part to the fact that few compounds are available with a low ratio of phosphate to other nutrients.

Except in one or two factory areas the use of salt on sugar beet is still very limited.

REFERENCES

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