

XXVI. *Report of some Experiments with Saline Manures containing Nitrogen, conducted on the Manor Farm, Havering-atte-Bower, Essex, in the occupation of Collinson Hall, Esq. By W. M. F. CHATTERLEY.*

Read December 6, 1842.

INDUCED by the prevailing opinion that upon the quantity of Nitrogen contained in some animal and saline manures, depend their fertilizing properties, it was decided to test, by experiment, the relative value of three saline manures containing that element as a constituent, viz. nitrate of potash, nitrate of soda, and sulphate of ammonia, all these salts, from their commercial price, being within the reach of the farmer for agricultural purposes, provided a sufficient amount of profit for the outlay can be shown, and that of course would be preferred by the agriculturist which yields the greatest profit on the prime expenditure.

For the purposes of the experiment a field of WHEAT was chosen, which in the latter end of April, 1842, presented a *thin plant*, the salts were top-dressed over the land by hand, on the 12th of May, in the quantities stated in the table below; the crop was mowed on the 10th of August, and the separate parcels taken from an eighth of an acre, threshed, measured, and weighed under my own inspection on the 24th of August. The results are as follow for the acre:—

No.	Dressing.	Cost per acre.	Produce of Corn & Straw per acre.	Produce of Corn per acre.		Weight of bu. of Corn.	Produce of Straw and Chaff per acre.		Increase of Corn per acre.		Cost of the In- crease of Corn per bushel.	Increase of Straw per acre.	Total In- crease per cent.	Profit on outlay per cent.
		£. s. d.	lbs.	lbs.	bu.	lbs.	lbs.	tru.	lbs.	b.p.q.	£. s. d.	lbs.	tr.	
1	No Manure.....		3700	1413	23½	59½	2287	63½						
2	28lbs. of Sulph. Am.	0 5 10	3900	1612½	26½	60	2287½	63½	199½	3 1 1	0 1 11½	½	—	14.1
3	140lbs. Ditto	1 1 9	4570	1999	32½	61½	2571	71½	586	9 0 0	0 2 5	296	8	41.5
4	112lbs. Nit. Soda ...	1 4 6	4390	1905	31½	60½	2485	69	468½	7 3 1	0 3 2	198	5½	34
5	112lbs. Nit. Potassa.	1 7 6	4264	1890	31½	60½	2378	66	453½	7 2 1	0 3 8	126	2½	33.5

The quantity of nitrogen per cent. in each of the pure salts is as follows:—

Sulphate of Ammonia (crystals)	per cent. 18.80
Nitrate of Soda	16.55
Nitrate of Potassa	13.96

This calculation leaves out of the question the adventitious water contained in the salts as they are met with in commerce, and which in nitrate of soda is very considerable, sometimes as much as 10 per cent., and besides, nitrate of potassa usually containing from 2 to 12 per cent. of chloride of sodium, would in each case reduce the per centage of nitrogen. The quantity of solid impurity in the sulphate of ammonia used in these experiments was less than one per cent.

The quantity of gluten in the different samples of wheat, which forms a very considerable item in the determination of the relative value of these manures, was not obtained, in consequence of the error of the foreman, who used the reserved samples for seed; but an approximation may be obtained by comparing the weights of equal bulks, as it is constantly found that the heavier the sample, the more water is absorbed by the flour made therefrom, and consequently the more gluten it contains: by referring to the column of the table which shows the weight of a bushel of each sample, it will be seen, that for the quantities used, sulphate of ammonia (Nos. 2 and 3) is superior to the nitrates of soda or potassa (Nos. 4 and 5).

The object of these experiments having been to approximate the original cost per acre of these manures, rather than their weights, is the reason why equal weights of sulphate of ammonia and nitrates were not used: neither is it believed that the result would at all correspond with the real result of the actual experiment were we to deduct one-fifth from the

product of No. 3 ; indeed, the product of an acre would not then greatly exceed for 112lbs. of manure that for 26lbs.

It will be observed that the produce of the three manures does not bear a relative proportion to the quantity of nitrogen contained in each, but this gives us no reason for believing that such proportion would not hold good had the quantity of water contained in each been allowed for at the time of dressing.

The attention of the practical agriculturist will probably be attracted to the last column of this table, in which is exhibited the profit on the expenditure in each case ; taking the average value of the bushel at seven shillings, and of a truss of straw at ninepence, and calculating chaff as the same value as straw for fodder. The difference between a quarter of a hundred weight and a hundred weight and a quarter of sulphate of ammonia is very remarkable, and, as may be easily perceived, is due to the difference of the value of the produce, the increase in the former instance being wholly in corn, while in the latter it is in both straw and corn, and it is probable that there is some quantity of the manure between these two extremes which would give the largest return relative to the outlay. It is clear however that if a farmer have but 1*l.* to lay out in manure, that the quantity of sulphate of ammonia to be obtained for that sum would give a larger return if spread over four acres of land than if bestowed upon one.

Sulphate of ammonia was also tried as a top-dressing upon a poor *pasture*, at the rate of one cwt. per acre ; the operation was performed in the evening after a shower of rain ; it was observed on the following day that the clover and some of the grass were withered, indicating that the moisture which remained on the leaves had caused the salt to adhere, and there form too strong a solution ; in about a week after this period the grass assumed a greener colour, especially in one part of the field which had been dressed twice over to observe the effect : the crop of hay was not weighed, in consequence of rain coming on at the time of making, but was laid at half a load more to the acre than the undressed portion, and no doubt was entertained that by applying such a dressing earlier (it was not applied till the 12th of May), and in a less drouthy season, more time would have been allowed for subsequent growth, and a much larger crop would have been obtained. The after-feed was decidedly improved, and very much preferred by the cattle.

On the same date a quantity of sulphate of ammonia at the same rate, was dressed over a single land in a field of *tares* : the leaves of the plant withered, as in the instance of the pas-

ture above-mentioned, the subsequent produce however was *one-sixth* more than any other land of the field. The oats sown with the tares grew extraordinarily after the application, and it is believed, that if applied earlier in the season to the tares as to the pasture, and during dry weather followed by less drought, the leaves of the plant would not have withered, and the effect would in both cases have been more marked.

On the 21st of May a similar quantity, viz. one cwt. to the acre, of sulphate of ammonia was applied to a field of *clover* in dry weather: in this instance the leaves did not wither, but no increased growth appeared to be the consequence; and a similar result was obtained by the application of nitrate of soda.

To a field of podding peas much infested with slug, the following dressing was applied early in the morning, and by ten o'clock an immense number of the dead insect covered the land:—

Sulphate of Ammonia . . $7\frac{1}{2}$ cwt. at 17s. 0d. 6l. 7s. 6d.

Common Salt 2 cwt. at 1 6 0 3 0

Oil Cake, finely powdered 7 cwt. at 6 6 2 5 6

this was sown broadcast, at the rate of $1\frac{1}{4}$ cwt. to the acre (value 14s. 6d.), and besides saving the plant by the destruction of the insect, seemed in a short time to have converted this crop, from the worst of two others in adjoining fields, into the best of the three, and little or none of the withering effect on the leaves ensued.

It will be observed from the above experiments, that sulphate of ammonia appears to have acted better upon graminaceous than upon leguminous plants; for though the crops of tares and peas seem both to have received considerable benefit from the application, such benefit was by no means in proportion to the effect produced upon wheat or oats; the oats sown with the tares, as has been before observed, growing surprisingly after the application, and exhibiting a marked distinction in their rate of increase.

Sulphate of ammonia, as well as nitrates of soda and potassa, comes under the class of stimulating manures; that is, such manures which, at the same time that they supply the plant with one or more ingredients necessary to the crop, enable it to obtain a larger supply of its usual nourishment from the soil and the atmosphere: hence the quantity of nitrogen itself in the crop from the land to which a nitrogenous manure has been applied, is greater than the sum of the nitrogen from the unmanured portion and the quantity contained in the manure so added; and hence the result of the application of a given quantity of such manure will vary upon different soils, and even

upon the same soil under different conditions, depending upon its capacity to supply the plant with its general nourishment. On account of this stimulant action, care should be taken in the application of these manures, that the quantity used should vary according to the condition of the plant and soil, as too large a quantity on a good plant, with a soil in high condition, would cause the crop to lodge, and a small dressing can always be repeated if found necessary.

From the above experiments and several others, which want of opportunity has prevented from being carried out so fully, but from which as an eye-witness a comparative opinion may be formed, I am led to believe that no cheaper top-dressing than sulphate of ammonia can be applied to wheat or oats on this land, which is generally a heavy clay upon a subsoil of London clay, when the plant requires it, either from its being sickly or thin on the ground, in consequence of the land being somewhat out of condition, whether from unusual wet, bad seed-time, uncongenial spring, or any such-like cause. I should add that equal benefit appears to have been derived from its use upon a light gravelly soil upon a subsoil of gravel, upon the same as the London clay formation.

With respect to the quantity of the salt to be used, it may be best to refer to the practical result of a large and small dressing, as shown in the table above (Nos. 2 and 3), and the previous remarks thereon as to the relative produce of straw and corn in each case, and to add, that although the experiment has not yet been made, there seems reason to believe that a better effect would result from the application of, say one cwt. per acre at three different dressings, than all at once, that is about 37lbs. when the crop of *wheat* makes its spring growth, or when *oats* are about two inches out of the ground; a similar quantity about a month afterwards; and again at the time of the formation of the ear. But a practical difficulty occurs in applying so small a quantity as 37lbs. of any material over an acre of ground: the simplest mode of overcoming this, unless we could use a machine capable of adjustment, similar to what is termed a clover drill, perhaps is to mix the salt with some substance which shall not exert any decomposing action upon it, but so increase its bulk as to enable it to be equally spread over the surface; the best substance, as far as my experience goes, is *common salt* (itself a manure very generally useful), twice the weight of the sulphate being added to make up one cwt., a quantity not difficult to broadcast over an acre: or if preferred, *soot*, which itself contains both sulphate and carbonate of ammonia; or even such a mixture as that before-mentioned used for peas, but then care

must be taken to pulverise the oil-cake sufficiently. A method which has been found to be good is to mix *soot* and *salt* in about equal parts, some weeks previous to the addition of the sulphate of ammonia; the salt condenses moisture from the atmosphere and fixes the carbonaceous particles, and these tend to hold the carbonic acid and ammoniacal gases derived from the atmosphere and decomposing organic matters in the soil, and render them of easy access to the plants. If a very speedy effect be required, the stimulating properties of this dressing may be increased, by setting free a portion of the ammonia by a subsequent *very slight* dressing of hydrate of lime (for obvious reasons this mixture should not be made before the sowing); but as such a dressing is always attended with loss of ammonia, this should never be resorted to unless it is otherwise unavoidable, and if possible when rain may be expected to fall. And this leads me to a remark on the very common practice, in this county particularly, of mixing fermenting farm-yard manure with lime, by which all the ammoniacal salts are decomposed and the ammonia driven off, and a large portion of fertilizing material absolutely lost: it is difficult however to convince the farmer accustomed to this practice, for the immediate benefit which results is considerable; for in the first place the vegetable tissues are broken up, and put in a condition more easily to be converted into carbonic acid, and hence more easily absorbed by plants, and besides its bulk is materially diminished, so that 20 loads of the mixture contains the vegetable matter thus prepared of perhaps 40 of the manure in its ordinary state, and there can be no doubt is more speedily exhausted.

The manures here referred to, and most other saline manures when used as a top-dressing, should be applied when the plant is dry after a shower of rain, or during hazy weather, but not when any continued fall of rain is anticipated; in the first instance it is slowly dissolved by dews, &c., and permeates the soil in every part, and in the latter a considerable portion of its effect is lost as the salt is washed out and carried away in solution by the drains. When the soil is too dry, it remains inactive. It is perhaps supererogative in the present day to insist upon thorough drainage for the effectual action of any manure; it must be clear that unless the soil has been well disintegrated and a free passage exists among its particles, neither moisture, air, nor manure, can thoroughly penetrate, and this condition is effected by drainage alone.

With regard to the use of sulphate of ammonia with the drill and depositing it with the seed: in some experiments

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made to determine the propriety of this mode of dressing the land, the result was a thin and bad crop, arising apparently from its having received a check during its early growth, and much of the seed having been killed as soon as germination took place; this may perhaps be accounted for by referring to the withering effect upon the leaves, observed in some of the other experiments, which may be supposed to be much more powerful upon the tender radicle and plumule in the earliest stages of development, while they are provided in the cotyledons of the seed with a mild and bland nourishment suitable for these tender organs, and before they are prepared for procuring or assimilating the stronger aliments fitted only for more mature plants.

Attention has been particularly directed to sulphate of ammonia on account of its low price as compared with other nitrogenous manures, a point upon which the extensive practical application of any manure must chiefly depend. The price paid was seventeen shillings per cwt. ; it is prepared at the Gasworks in Brick Lane by a patent process for purifying coal-gas by means of dilute sulphuric acid, and is very free from impurity.

A specimen of manure sold as Daubeny's sulphate of ammonia at 12s. the cwt. did not give any traces of ammonia when mixed with caustic lime, but consists almost entirely of sulphate of lime, and is worth no more to the farmer than gypsum which may be obtained at 2*l.* a ton.

This manure is said to be prepared according to the directions of Dr. Daubeny of Oxford, by pouring the ammoniacal liquor of the gasworks upon finely-powdered gypsum: even if it were so, the per centage of sulphate of ammonia to be thus obtained, cannot make its value as compared with pure sulphate of ammonia as 12 to 17; and its name, "Daubeny's Sulphate of Ammonia," unqualified as it is by any explanation of its composition, is liable to lead the agriculturist unable to detect its nature, into serious loss and error.

I may perhaps be permitted to remark, that the nitrogen of coal is the store accumulated by the vegetation of past ages, before man converted it to his use, but now that this inexhaustible source of a material so necessary to increase the quantity of food to be obtained from the present race of plants is opened, it is proper to examine the most advantageous mode of employing it, that so great a boon be neither neglected nor wasted: it should therefore seem to be the duty of all who have it in their power, to confirm or refute the accuracy of such experiments as the above, and if, as I

cannot doubt, they are found to be nearly correct, to promulgate as much as possible the facts, in order that so valuable a material may be speedily appreciated by the British agriculturist.

In conclusion I have to add, that these experiments were not originally commenced with that attention to rigid accuracy which is called for in strictly scientific investigations, for they were in fact intended to serve as illustrations to a course of practical lectures on the application of science to agriculture delivered on the spot, and this may form some excuse for the omission of certain data which could easily have been obtained, but which did not appear necessary until it was decided to calculate and exhibit the results in a tabular form.
