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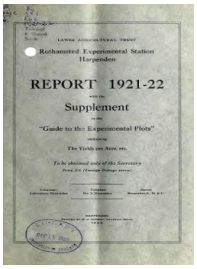
Report 1921-22 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Woburn Experimental Farm Report 1921-1922

Dr J. A. Voelcker

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WOBURN EXPERIMENTAL FARM.

REPORT FOR 1922 BY DR. J. A. VOELCKER.

SEASON.

Beginning with a warm, dry October 1921, autumn cultivation and sowing made good progress. The winter was marked by little rain and only occasional frosts; it was followed by a cold and sunless spring which retarded the growth of winter-sown crops, and by a very wet April which delayed the sowing of spring crops. The early part of May was cold and wet, the latter hot and dry, this continuing throughout June and making the obtaining of a good swede crop difficult. In July rainfall was excessive, and, from then to harvest, cold and wet weather, with absence of sunshine, prevented the proper ripening of corn crops, all being considerably damaged by rain. Mangolds, being put in early, were an excellent crop, as also Potatoes, but Swedes were almost an entire failure, and Hay, though a fairly large crop, was not of good quality.

The rainfall for the season was 25.41 inches, there being 193 days on which rain fell. The rainfall was heaviest in July (4.02 ins.), and in April (3.89 ins.); in August and September, 2.07 ins. and 2.48 ins. of rain fell.

FIELD EXPERIMENTS, 1922.

1. *Continuous Growing of Wheat* (Stackyard Field), *46th Season.*

"Red Standard" wheat (10 pecks to the acre) was drilled on October 10th, 1921. Farmyard manure (plot 11B) was ploughed in on October 5th, Rape Dust (plot 10B) on October 8th, and mineral manures given to the several plots at the time of drilling the wheat. The nitrogenous top-dressings were put on May 17th and June 17th, 1922.

The wheat crop was cut on August 11th, stacked August 29th, and threshed on December 22nd.

The results are given on page 62.

The crop results were very similar to those of 1920.

The main features shown are: — The unmanured produce averaged 8.5 bushels of corn with 7 cwt. of straw per acre; farmyard manure gave only 2 bushels more per acre, Rape Dust doing

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Continuous Growing of Wheat, 1922 (46th Season).

(Wheat grown year after year on the same land, the manures being applied every year.)

Stackyard Field—Produce per acre.

Plot.	Manures per acre.	Head Corn		Tail corn	Straw, chaff, &c.
		No. of bushels.	Weight per bushel.	Weight	
			lb.	lb.	cwt. q. lb.
1	Unmanured	8.9	59.7	8	8 0 16
2a	Sulphate of ammonia (=25 lb. ammonia)	1.4	60	—	1 2 24
2aa	As 2a, with 5 cwt. lime, Jan., 1905, repeated 1909, 1910 and 1911	8.8	60	12	8 2 0
2b	As 2a, with 2 tons lime, Dec., 1897	10	60	2	9 1 26
2bb	As 2b, with 2 tons lime (repeated), Jan., 1905	9.4	60	6	8 0 8
3a	Nitrate of soda (=50 lb. ammonia)	13.8	58.2	18	12 2 0
3b	Nitrate of soda (=25 lb. ammonia)	13.4	59.7	10	11 1 12
4	Mineral manures (superphosphate, 3 cwt.; sulphate of potash, ½ cwt.)	7 7	60	6	9 0 16
5a	Mineral manures and sulphate of ammonia (=25 lb. ammonia)	14 1	61	12	14 1 24
5b	As 5a, with 1 ton lime, Jan., 1905	16.7	61	8	16 3 16
6	Mineral manures and nitrate of soda (=25 lb. ammonia)	14.0	60.2	8	13 2 2
7	Unmanured	8.1	60 7	4	6 2 0
8a	Mineral manures and (in alternate years) sulphate of ammonia (=50 lb. ammonia)	4.8	60	36	7 2 24
8aa	As 8a, with 10 cwt. lime, Jan., 1905, repeated Jan., 1918	9.9	60	12	10 1 12
8b	Mineral manures, sulphate of ammonia (=50 lb. ammonia) omitted (in alternate years)	3.8	60	—	4 2 16
8bb	As 8b, with 10 cwt. lime, Jan., 1905, repeated Jan., 1918	9.9	60	16	11 0 0
9a	Mineral manures and (in alternate years) nitrate of soda (=50 lb. ammonia)	11.3	59.2	4	11 2 14
9b	Mineral manures, nitrate of soda (=50 lb. ammonia) omitted (in alternate years)	8.0	61.2	6	9 1 0
10a	Superphosphate 3 cwt., nitrate of soda (=25 lb. ammonia)	18.3	60	12	16 0 0
10b	Rape dust (=25 lb. ammonia)	13.5	61	8	13 0 24
11a	Sulphate of potash 1 cwt., nitrate of soda (=25 lb. ammonia)	11.8	60	8	14 3 16
11b	Farmyard manure (=100 lb. ammonia)	10.8	59.7	8	13 2 20

better (5 bushels increase); the highest crop was 18.3 bushels of corn per acre from superphosphate and nitrate of soda, the next best, 16.7 bushels, being from minerals and sulphate of ammonia, with lime.

Apparently the 10 cwt. per acre of lime applied last in 1918 to plots 8aa, 8bb, was nearly worked out, but the 1 ton per acre (plot 5b) continued to show an influence, as did, to a slight extent still, the 2 tons (plot 2b) given as far back as 1897.

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2. *Continuous Growing of Barley* (Stackyard Field), *46th Season.*

Owing to the wet state of the land it was not possible to drill the barley until April 18th, 1922, when "Plumage Archer" (10 pecks per acre), was sown, the mineral manures going on at the same time. Farmyard manure had been previously (March 13th) ploughed in on plot 11B, and Rape Dust (plot 10B) applied on April 12th.

The nitrogenous top-dressings were given on June 17th and July 3rd.

The barley, despite an unfavourable season, grew better than usual; this may in no small measure be due to selected seed being used; indeed, the variety ("Plumage Archer") proved, over the farm generally, to answer considerably better than the other varieties, "Bevan's Archer" and "Chevalier," also grown. The newly-limed plots (3aa and 3bb, limed January, 1921,) seemed, from the outset, to be better than the unlimed. The crop was cut on September 11th, stacked October 11th, and threshed on December 21st.

The results are given on page 64.

The crop was the highest recorded since 1917, the unmanured produce being 13.5 bushels of corn and 9½ cwt. of straw per acre. The highest yield was 38.3 bushels of corn per acre, with farmyard manure; the next highest, 33.8 bushels, with minerals and nitrate of soda. Unlike with wheat, rape dust gave but a poor crop. As in previous years, the use of potash (plot 11a) seemed to benefit the barley more than that of phosphate. The most striking results, however, are those showing the influence of lime. Not only have there been notable increases in plots 2B, 2BB, 5AA, 5B, 8AA, and 8BB, as compared with the corresponding unlimed plots, but, where lime was put on plots previously treated for many years with nitrate of soda, there was a marked restoration of the yield, though the lime had only gone on the year previous. It would appear from this that not only where sulphate of ammonia is used continually is lime a necessity, but that lime will also tell where nitrate of soda has been similarly used.

It should be mentioned that some of the barley area was attacked by "gout-fly," and this was investigated on the spot by Mr. Frew, of the Entomological Department. The plots least affected were the ones most highly manured.

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Continuous Growing of Barley, 1922 (46th Season).

(Barley grown year after year on the same land, the manures being applied every year.)

Stackyard Field—Produce per acre.

Plot	Manures per acre	Head Corn: No. of bushels	Head Corn: Weight per bushel	Tail corn: Weight	Straw, chaff, &c.
			lb.	lb.	cwt. qr. lb.
1	Unmanured	14 9	49.5	19	10 2 18
2a	Sulphate of ammonia (= 25 lb. ammonia)	4.9	54	—	2 3 12
2aa	As 2a, with 5 cwt lime, Mar., 1905, repeated 1909. 1910, and 1912 .	6.3	56	—	5 1 8
2b	As 2a, with 2 tons lime, Dec., 1897, repeated 1912	23.6	48.2	40	13 0 24
2bb	As 2a, with 2 tons lime, Dec., 1897, repeated Mar., 1905 . . .	24.0	48.2	40	10 3 24
3a	Nitrate of soda (=50 lb. ammonia) .	11.4	51	28	6 3 12
3aa	As 3a, with 2 tons lime, Jan., 1921 .	23.0	47.2	32	16 0 4
3b	Nitrate of soda (=25 lb. ammonia) .	17.3	48.2	32	8 3 8
3bb	As 3b, with 2 tons lime, Jan., 1921 .	21 4	47.5	44	10 0 16
4a	Mineral manures[1]	18.0	49.7	24	10 3 26
4b	As 4a, with 1 ton lime, 1915 . .	19.3	49.7	30	11 1 16
5a	Mineral manures and sulphate of ammonia (=25 lb. ammonia) .	13.6	50	24	9 1 8
5aa	As 5a, with 1 ton lime, Mar. 1905, repeated 1916 . . .	28.8	49.7	44	14 1 4
5b	As 5a, with 2 tons lime, Dec. 1897, repeated 1912	26 9	48.4	42	15 3 0
6	Mineral manures and nitrate of soda (=25 lb. ammonia) . . .	30 0	48.5	46	16 0 9
7	Unmanured	12.6	48.7	20	8 2 12
8a	Mineral manures and (in alternate years) sulphate of ammonia (=50 lb. ammonia) . . .	2.0	50	—	0 3 12
8aa	As 8a, with 2 tons lime, Dec., 1897, repeated 1912	26 2	48.7	56	16 3 16
8b	Mineral manures, sulphate of ammonia (=50 lb. ammonia) omitted (in alternate years) . . .	1.3	50	—	1 0 0
8bb	As 8b, with 2 tons lime, Dec., 1897, repeated 1912	17.7	50.5	24	12 3 0
9a	Mineral manures and (in alternate years) nitrate of soda (=50 lb. ammonia)	33.8	47.3	76	19 2 6
9b	Mineral manures, nitrate of soda (=50 lb. ammonia) omitted (in alternate years)	27.3	48.5	34	14 1 18
10a	Superphosphate 3 cwt., nitrate of soda (=25 lb. ammonia) . . .	25.1	47	46	14 1 26
10b	Rape dust (=25 lb. ammonia) . .	10.8	49	26	7 2 4
11a	Sulphate of potash 1 cwt., nitrate of soda (=25 lb. ammonia) . .	29.1	49	44	17 3 24
11b	Farmyard manure (=100 lb. ammonia)	38.3	49.6	78	19 2 20

[1] Superphosphate 3 cwt., sulphate of potash ½ cwt.

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3. *Rotation Experiments.*

The Unexhausted Manurial Value of Cake and Corn (Stackyard Field).

(*a*) Series C, 1922. Swedes.

The previous rotation being concluded with wheat (1921) following red clover, swedes were put in as the first crop of the new rotation. The drought towards the end of May and throughout June made the swede crop very uncertain; the seed was drilled on June 18th, mineral manures (superphosphate 3 cwt., sulphate of potash 1 cwt., per acre) being applied shortly before (May 26th). A plant was, with difficulty, obtained, and a small crop, though uniform over the area, was grown. A top-dressing of 1 cwt. per acre nitrate of soda was given after singling. The crop was, later on, fed off with sheep, one half with cake, the other half with corn.

(*b*) Series D, 1922. Barley after Swedes.

The swede crop of 1921 being too small to feed off on the land, it was removed, and barley ("Beaven's Archer") drilled on April 11th, superphosphate 2 cwt. per acre and sulphate of potash 1 cwt. per acre having been applied April 7th. 1 cwt. sulphate of ammonia per acre was given later as a top-dressing. Red clover was sown in the barley on May 22nd. The barley was only a moderate crop and was cut on September 30th. It took a long time to cart, owing to bad weather, but was ultimately stacked October 11th, and was threshed December 16th.

The results follow.

Rotation Experiment—the Unexhausted Manurial Value of Cake and Corn. Series D (Stackyard Field), *1922—Barley after Swedes (carted off).*

Plot		Head corn		Tail corn	Straw, chaff, etc.		
		Bushels.	Weight per Bushel.	Weight.			
			lb.	lb.	cwt.	qr.	lb.
1	Corn-fed Plot	22.3	47.5	42	10	1	24
2	Cake-fed Plot	20.3	49	52	9	3	3

The yield was poor, and not equal to the manured plots of the continuous barley series in the same field, where, however, "Plumage Archer" had been grown as against "Beaven's Archer" here. Moreover, the yield after feeding of corn was somewhat above that after feeding of cake.

4. *Green Manuring Experiments, 1922.*

(*a*) Stackyard Field. Series A.

After the growing of green crops (tares and mustard) in 1921 it was decided to make a change in these plots, the whole area of 4 acres being divided into an upper and a lower half, and a re-arrangement made by which, while the alternation of green crop and corn crop was kept up, there should be every year one half in

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green crop and the other half in corn. Further, it was decided to limit future enquiry to the two green crops, tares and mustard, both in this field and in Lansome Field, and to omit the third crop, rape.

Accordingly, after the green crops of 1921 had been fed off by sheep, wheat was sown over the lower 2 acres, and green crops again on the upper 2 acres. Wheat ("Red Standard") was drilled on October 12th, and winter tares on 1 acre on October 12th. Mustard followed on the remaining 1 acre on May 27th, 1922.

It was very noticeable that the tares were markedly better on that part of the land where in earlier years (since 1911) rape had been grown, than where tares followed tares; a like difference was seen on the lower half with the wheat crop, this being better on the strip that had carried rape than where tares had been the crop. This would seem to open a question as to whether the repetition of the tares crop had not had an injurious effect.

The wheat, following green crops fed on, made little progress, and was a very disappointing crop. It was cut on August 24th, stacked, and threshed December 22nd.

The results follow.

Green Manuring Experiment (STACKYARD FIELD).

Produce of Wheat per acre, 1922—after Green Crops. Series A.

Plot		Head Corn		Tail Corn	Straw, Chaff, etc.
		Bushels.	Weight per Bushel	Weight	
			lb.	lb.	cwt. qr. lb.
1	After Tares fed off . . .	6.9	60	5	7 3 3
2	After Mustard fed off . .	7.5	58.6	6	8 2 5

These poor results are quite unaccountable, especially when it is remembered that on land only a few yards off in the same field the unmanured yield after 46 years was higher than here. Moreover, not only had very fair green crops been grown in 1921, but these had been fed off by sheep which had 1½ cwts. of cotton cake per acre as well. This opens up a whole series of problems in relation to green manuring, and which call for careful investigation.

The tares on the upper half grew well, were fed off by sheep, in July, 1922, receiving ¾ cwt. cotton cake per acre, and then a second crop of tares was grown, this being similarly fed off along with cake in October. Mustard, sown on May 27th, was fed off with cotton cake, a second crop then grown and this likewise fed off.

(*b*) LANSOME FIELD.

Green crops of tares and mustard had been grown on the old plots of this experiment in the summer of 1921, and were ploughed in towards the end of July. The area was then extended by the addition of 3 more ¼-acre plots, one of tares, one of mustard, and the third left as a control plot. To all the plots alike (now 5 in

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number) basic slag at the rate of 5 cwt. per acre, and sulphate of potash 1 cwt. per acre, were given on October 14th, 1921, and tares and mustard again sown. These did not come to much, and so the land was cleaned and green crops again put in on June 28th, 1922, when they grew much better; the mustard was ploughed in August 28th and the tares October 16th, wheat then being drilled over the whole area.

5. *Malting Barley Experiments.*

Experiments were carried out, in conjunction with Rothamsted and other centres, on the influence on yield and quality produced with barley by different manures and combinations of these. The variety of barley supplied was "Plumage Archer."

(*a*) Warren Field.

The field selected at Woburn was the heaviest one on the farm, the soil being a fairly heavy sandy loam, just on the junction of the Lower Greensand and Oxford Clay formations. Previously the land had grown a crop of mangolds which had had 8 tons per acre of farmyard manure. Five plots of ¼-acre each were marked out, and barley—at the rate of 10 pecks per acre—was drilled on April 19th, 1922. Mineral manures were applied at the time of sowing the seed, in accordance with the plan given below, the nitrogenous top-dressings being applied later, *viz.*, on June 20th.

The crops grew well and showed but small differences until nearing harvest, when, owing to the unfavourable weather, they got somewhat "laid," and ripening was much retarded. Plot 2 (complete artificials) was the least "laid," and plots 3 (no nitrogen) and 4 (no potash) were rather before the others in ripening.

The crops were cut September 9th, 1922, and threshed January 24th, 1923.

The results are given in the following table:—

Malting Barley Experiments (Warren Field), *1922.*

Produce of Barley per acre, after Mangolds (manured).

Plot	Manures per acre	Head Corn: Bushels	Head Corn: Weight per Bushel	Tail Corn: Weight	Straw, Chaff, etc.
			lb.	lb.	cwt. q. lb.
1	No manure	42.5	49.9	54	28 3 18
2	Complete Artificials { Superphosphate 3 cwt. Sul/Potash ½ cwt. Sul/Ammonia 1 cwt. }	44.7	48.9	65	26 3 0
3	{ Superphosphate 3 cwt. Sulphate of Potash 1½ cwt. }	45.0	47.1	66	31 2 10
4	{ Superphosphate 3 cwt. Sulphate of Ammonia 1 cwt. }	41.8	48.4	62	29 0 4
5	{ Sulphate of Potash 1½ cwt. Sulphate of Ammonia 1 cwt. }	39.9	49.1	50	29 0 8

The differences between the plots were but small, and, the unmanured produce itself reaching 42½ bushels per acre, showed that the land was a good deal richer than had been expected, and that it really needed no more manuring.

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(*b*) Great Hill.

Simultaneously with the foregoing, an experiment on an adjoining field of light sandy soil, but entirely on the Lower Greensand formation, was carried out. A light crop of swedes had been fed on this land by sheep, receiving also a little cotton cake. It was desired to see whether mineral superphosphate given in addition proved an advantage to the following barley crop.

Two plots of ½-acre were marked out, and to one of them superphosphate at the rate of 3 cwt. per acre was given previous to the drilling of barley ("Plumage Archer") on April 25th.

The crop was cut on September 16th, 1922, and threshed on January 24th, 1923.

The results were :—

Malting Barley Experiments (Great Hill), *1922.*

Produce of Barley per acre, after Swedes fed off by Sheep.

Plot	Manures	Head Corn		Tail Corn	Straw, Chaff, etc.
		Bushels	Weight per bushel	Weight	
			lb.	lb.	cwt. q. lb.
1	With Superphosphate . .	34.6	51.5	99	16 3 15
2	Without Superphosphate .	38.4	51.1	69	17 1 11

On this lighter soil the crop was lower than on Warren Field, but was by no means a bad one for the land. The straw, however, was much shorter, and only about half the yield of Warren Field. The addition of superphosphate did not appear to have increased the yield either of corn or of straw.

7. *Experiments with Potassic Fertilisers* (*Sulphate and Muriate*) *on Potatoes.*

In 1922, experiments were carried out at Woburn, in common with other centres, for the purpose of testing the respective influence of sulphate of potash and muriate of potash, on the yield, quality, etc., of potatoes. The field selected at Woburn was Lansome Field, and the variety "Kerr's Pink," the seed having been obtained direct from Perthshire.

The soil is a light sandy loam, very suitable for the growth of potatoes. Spraying with *Bouillie Bordelaise* was carried out on September 1st and 2nd, and a second time on September 20th, though there was but little appearance of disease. It was noticed during growth that the plots treated with muriate of potash were lighter in colour than those with sulphate of potash, and also that the tops were bigger where no farmyard manure had been given.

The lifting of the crop began on November 15th when the crops were weighed, and the returns are shown on page 69. In this table the weights are recorded as taken when the crop was lifted, whereas the separation into "ware," "seed," and "diseased" was not made until several months later when the potatoes were actually sold. Owing to difficulties in disposing of

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Experiments with Potassic Fertilisers on Potatoes (LANSOME FIELD), *1922.*

Produce per acre.

Plot.	Manuring per acre.	Kerr's Pink. Weight per acre.			
	Series A *with* Farmyard Manure 12 tons.	T.	c.	q.	lb.
1	Superphosphate 4 cwt. + 1½ cwt. Sulph. Potash	12	2	0	0
3	Sulph. Ammonia 1½ cwt.	12	10	1	20
2	Superphosphate 4 cwt. + equivalent in Muriate of Potash	13	14	0	16
4	Sulph. Ammonia 1½ cwt.	12	1	3	16
	Series B *without* Farmyard Manure.				
5	Superphosphate 6 cwt. + 1½ cwt. Sulph. Potash	13	8	2	12
7	Sulph. Ammonia 2 cwt.	13	8	1	24
6	Superphosphate 6 cwt. + equivalent in Muriate of Potash	13	13	0	12
8	Sulph. Ammonia 2 cwt.	13	19	1	12

the crop, the actual removal from the heaps and sale only began in the middle of March, 1922, and continued till the close of May. Hence a division of the crop into the three sections would give no fair comparison, as the shrinkage in weight owing to storage, sprouting, etc., would vary with the time of keeping.

It may, however, be said that there was, on the average, no difference between sulphate of potash and muriate of potash either in respect of "seed"—which worked out at 7%—or of "diseased"—which did not exceed 1%.

The duplicates, with the exception of plots 2 and 4, agreed very fairly. Muriate of potash gave, on the average, 10 cwt. per acre more yield than did the same amount of potash as sulphate. Also the yield was 1 ton per acre more where, in place of farmyard manure, additional superphosphate and sulphate of ammonia were used.

The crop all round was a splendid one; it gave but few diseased tubers, and, after being pitted, it kept well throughout the winter and right on to May, 1923.

POT-CULTURE EXPERIMENTS, 1922.

Though the transference to Cambridge of the work hitherto done at Woburn under the terms of the Hills' bequest, brought to an end my official connection with this, yet the experience I had derived during a period of 25 years, and the interest I felt in the methods of enquiry pursued, determined me to carry on the experiments so far as I found this possible. Similarly, the many enquiries that had been initiated and were still in progress in connection with the Woburn field experiments rendered it desirable that these, too, should be continued. This I have succeeded in doing, and the present is an account of the work carried on in 1921-22.

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I. *The Hills' Experiments.*

These—if I may be allowed still to apply the term to them—embraced in 1922 :—

(*a*) The action of compounds of Lead on wheat.
(*b*) The action of Chromium compounds on wheat.

(*a*) Lead Compounds.

In previous work in 1912 (Journal R.A.S.E., 1912, pp. 324-5) it was found that lead salts, when present to the extent of .03% of lead in the soil, exerted no harmful influence in the case of the phosphate, nitrate or carbonate. In 1914 (Journal R.A.S.E., 1914, pp. 312-3) the same salts, but in higher amount (up to .10% of lead), and with the sulphate and chloride additionally tried, similarly failed to show any injurious effect. The subject was then left for a time, but I returned to it now, taking still higher amounts of the metal and using the following compounds of lead, the oxide (litharge), carbonate, sulphate and chloride. The quantities now employed were respectively .25%, .50% and 1% of the metal. The salts were mixed with the whole of the soil in each pot, and each experiment was, as usual, in duplicate, the soil being that from Stackyard Field.

Wheat was sown on December 20th, 1921, and nothing was noticeable with regard to germination except in the case of the lead chloride sets. In these .25% slightly retarded germination, .50% still more so, and 1% very markedly. The full number of plants did not come up in any of these.

The only differences between the crops, and only signs of any toxic influence were with the chloride; with this, .25% did not appear to do any harm, but with .50% there were only one or two weakly plants left, while with 1% the few plants that came up at first died away entirely.

Plate I. shows the appearances very clearly, and the comparative weights in the case of the chloride are given below.

Lead Chloride upon Wheat, 1922.

Treatment		Corn	Straw
Untreated		100	100
Lead Chloride . . .	.25% Lead	136.3	116.1
Lead Chloride . . .	.50% Lead	—	—
Lead Chloride . . .	1% Lead	—	—

From this experiment it would result that lead present as chloride in a soil will produce a toxic effect as soon as the quantity exceeds .25% of lead, but that in the forms of the oxide, carbonate and sulphate, no harmful influence is exercised up to 1% of lead.

(*b*) Chromium Compounds on Wheat.

1.—The experiments of 1920 and 1921 with chromate and bichromate of potash were continued for a third year, the same pots without alteration or addition being used again for a third corn crop which was sown on October 27th, 1921.

By way of recapitulation, it may be said that in the first year

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PLATE I.—LEAD COMPOUNDS UPON WHEAT, 1922.

(*a*) Untreated; (*b*) 1 per cent. Lead as Oxide; (*c*) 1 per cent. Lead as Carbonate; (*d*) 1 per cent. Lead as Sulphate; (*e*) ·25 per cent. Lead as Chloride; (*f*) ·50 per cent. Lead as Chloride; (*g*) 1 per cent. Lead as Chloride.

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.025%, .01% and .005% of chromium were shown to be fatal to barley, whether chromate or bichromate was used, and that in the second year only the .025% proved still harmful to wheat, any injurious effect from .01% and .005% having passed off. Now in the third year, wheat being again sown, the .025% also lost its ill effect, and exercised, as did the lower amounts, a slightly stimulating influence.

2.—The fresh experiments started in 1921 with chromate and bichromate of potash, and also with chromic acid, were continued in 1922 with a second wheat crop. In 1921 it had been found that .005% of chromium was not a safe amount to use, whether as chromate or bichromate of potash or as chromic acid, but that smaller amounts of .0025% and .001% exercised a decidedly stimulating influence. On continuing, without further additions, for a second wheat crop in 1922, the results showed that a marked increase of crop was obtained from the .005% application (which the year before had been destructive), and a like, but decreasing, benefit from the smaller applications.

Putting together the results of 1 and 2 as here described, the general conclusion is reached that, while .005% of chromium is not a safe amount to have in a soil for the first year of growth of a corn crop, smaller quantities will not prove harmful, but rather stimulating, and that .005%, and even .01%, will lose its injurious effect in a second year, and .025% in a third year, a stimulating influence taking then the place of a previously harmful one.

The changes shown in the first 2 years may be illustrated by the accompanying curves obtained with potassium bichromate.

II. *The Relative Effects of Lime and Chalk, 1922.*

This experiment, a duplicate, in pot-culture, of the field experiment in Stackyard Field (Series B) started in 1919, was continued for a fourth year, no further additions being given, and wheat being sown again on October 26th, 1921.

Lime, it may be recalled, was given at the rates of 10 cwt., 1 ton, 2 tons, 3 tons, and 4 tons per acre respectively, and chalk to supply the same amounts of lime (CaO). The results obtained were very similar to those of 1920, and in the following table the figures for the 4 years are collected.

Lime and Chalk upon Wheat.

Treatment	1919 Barley		1920 Wheat		1921 Wheat		1922 Wheat		Average of 4 Years	
	Corn	Straw	Corn	Straw	Corn	Straw	Corn	Straw	Corn	Straw
No Lime	100	100	100	100	100	100	100	100	100	100
Lime (CaO) 10 cwt. per acre	120	116	117	107	128	108	98	113	116	111
,, ,, 1 ton ,, ,,	144	165	124	112	161	138	129	118	140	133
,, ,, 2 tons ,, ,,	233	245	131	112	195	150	133	119	173	156
,, ,, 3 ,, ,, ,,	293	292	150	132	217	151	133	119	198	173
,, ,, 4 ,, ,, ,,	299	314	149	126	264	176	149	129	215	186
No Lime	100	100	100	100	100	100	100	100	100	100
Chalk=CaO 10 cwt. per acre	98	103	107	96	106	99	108	103	105	100
,, ,, 1 ton ,, ,,	113	109	127	111	130	101	127	110	124	108
,, ,, 2 tons ,, ,,	113	114	116	105	148	123	132	123	127	116
,, ,, 3 ,, ,, ,,	124	114	106	107	153	145	111	112	123	119
,, ,, 4 ,, ,, ,,	106	111	119	92	153	124	119	122	124	112

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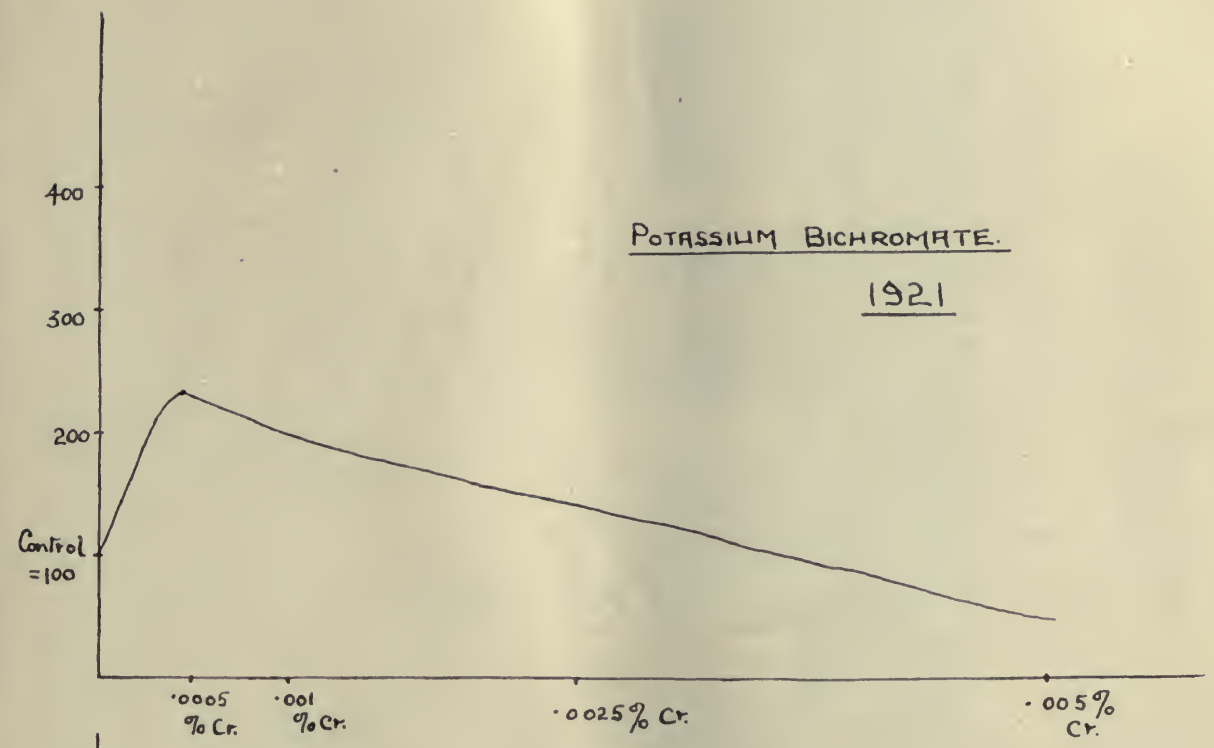

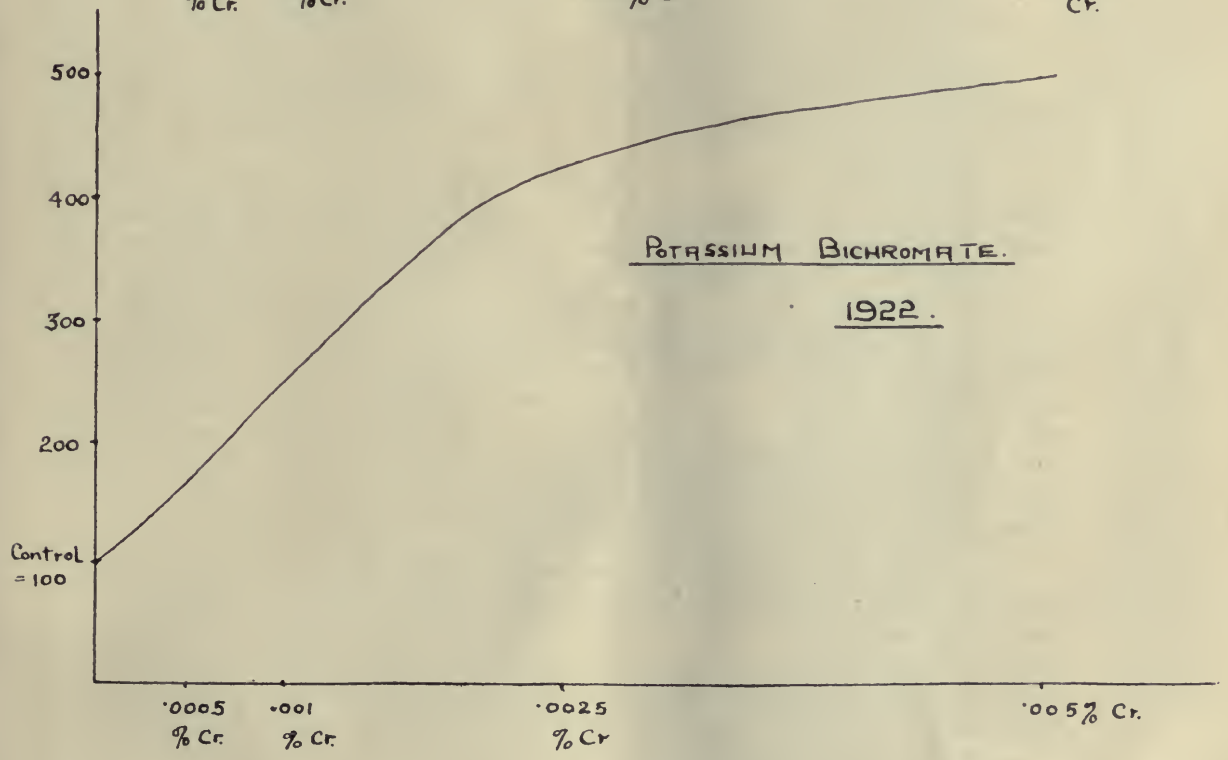

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With lime—as caustic lime—there was thus a progressive increase as more lime was used, right up to 4 tons per acre, the increase being shown most the first and third years; with chalk, however, though there was a slight increase, it was a much smaller one and not a regularly increasing one with the amount applied. It can, therefore, be hardly maintained that lime and chalk act similarly in the soil, or that it is immaterial whether one or the other be used, so long as the same amount of lime (CaO) is applied. In the present instance the soil was one notably deficient in lime, and here, at all events, the caustic lime has proved markedly more effective. As noted in the last report (Journal R.A.S.E., 1921, pp. 290-1) this experiment raises several important questions, *e.g.*, whether lime retains its causticity longer than is generally believed to be the case, or whether it becomes converted into silicate of lime or other forms in which it continues to have a marked effect. That it does not merely become changed straightway into carbonate of lime (as is generally supposed), and acts in the same way as chalk, would seem to be abundantly disproved by this 4 years' work. Were this the case, there is no reason why the results with chalk should not have been equal to those of caustic lime. As the outcome of this enquiry, I am convinced that the method commonly adopted of estimating the lime requirements of a soil by determining only the amount of lime present as carbonate of lime is incorrect.

III. *The Influence of Fluorides on Wheat, 1922* (2nd Year).

The experiments of 1921 were continued for a second year, no further additions being given, but wheat was again sown on October 27th, 1921.

It may be repeated here that the 1921 experiments showed a decidedly stimulating influence exercised by potassium fluoride used in quantity containing .05 and .1% of fluorine respectively, but that with sodium fluoride a complete alteration of the condition of the soil took place, this becoming hard and caked on the surface, very impervious to water, and dark in colour. Further, while the smaller amount of sodium fluoride (.05% fluorine) affected germination and killed a number of the plants, the few that survived grew most vigorously. With the higher amount (.1% fluorine) though a few plants came up, they were all eventually killed off. Potassium fluoride showed none of these changes in the soil, nor harm to the crop.

In the second year the germination with sodium fluoride was hardly affected by the smaller amount (.05% fluorine), but was markedly so with the higher quantity (.10%). Much the same general results were obtained as in 1921, except that the lower quantity of sodium fluoride did not kill off the plants, but produced a stimulating effect on them. The higher amount (.10% fluorine), however, as in 1921, killed everything off.

The appearances are shown in Plate II, and the comparative results are given in the following table:—

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A B C D E F G

PLATE II.—FLUORIDES UPON WHEAT, 1922.

(*a*) Untreated; (*b*) Calcium Fluoride 5 cwt. per acre; (*c*) Potassium Fluoride, giving ·1 per cent. Fluorine to soil; (*d*) Potassium Fluoride, giving ·05 per cent. Fluorine to soil; (*e*) Sodium Fluoride, giving ·1 per cent. Fluorine to soil; (*f*) Sodium Fluoride, giving ·05 per cent. Fluorine to soil; (*g*) Calcium Silico-Fluoride, 5 cwt. per acre.

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Fluorides on Wheat, 1922.

Treatment.	Corn	Straw
Untreated	100	100
Calcium fluoride 5 cwt. per acre	170.3	139.5
Potassium fluoride containing .1 per cent. Fl.	470	262
,, ,, ,, .05 ,, ,,	451	244
Sodium fluoride ,, .1 ,, ,,	—	—
,, ,, ,, .05 ,, ,,	292	202
Calcium-silico-fluoride 5 cwt. per acre	55.4	76

IV. *The Influence of Silicates on Wheat, 1922* (3rd Year).

The experiments of 1920 and 1921 were carried a further stage, no further additions being given, but wheat being sown again in the pots on December 21st, 1921. The previous years had shown calcium silicate to give an increase in the crop as the amount of it was increased, and this up to an application of 4 tons per acre, the increase being more marked the second than the first year. On the other hand, kaolin produced no effect, and magnesium silicate a less marked one than calcium silicate.

The 1922 results were of similar nature, showing a continued benefit from calcium silicate, increasing as more was used, while that of magnesium silicate was, on the whole, less.

The three years' results follow :—

Silicates upon Wheat, 1920-2.

Treatment	1920		1921		1922	
	Corn	Straw	Corn	Straw	Corn	Straw
Untreated	100	100	100	100	100	100
Calcium silicate, 1 ton per acre	113.4	104.1	146	126	128	107
,, ,, 2 tons ,, ,,	124.4	116.8	187	136	150	117
,, ,, 4 ,, ,, ,,	150.1	139.0	226	159	197	140
Magnesium silicate, 1 ton per acre	111.9	115.1	96	115	97	101
,, ,, 2 tons ,, ,,	109.5	124.5	149	135	168	110
,, ,, 4 ,, ,, ,,	113.5	135 4	172	139	179	123
Kaolin, 1 ton per acre	83.8	104.3	68.5	83	70	81.5
,, 2 tons ,, ,,	96.5	100.3	?	77.5	76	71
,, 4 ,, ,, ,,	103.0	96.8	108	98.5	98	102

From this it would appear to be clearly established that calcium silicate is a far from inactive form of lime, and that this may have a bearing upon the experiments recorded under II. in this section, as regards the relative efficiency of lime and chalk.