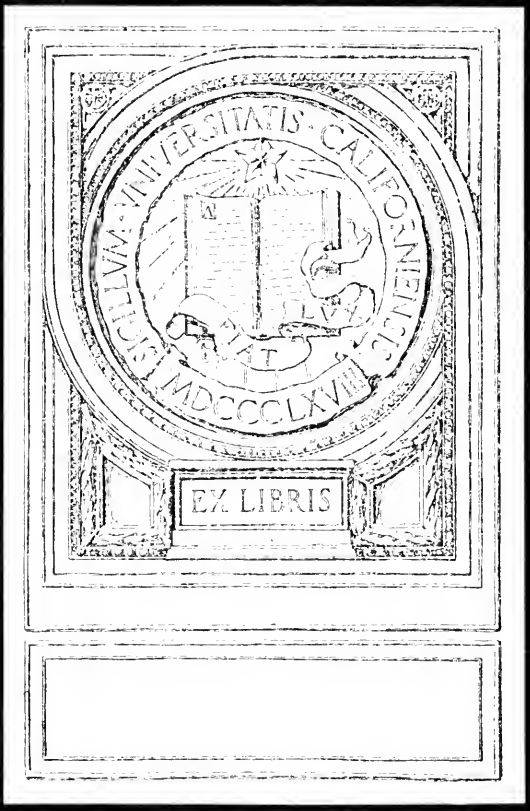
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Are Soils Containing Less than 0.02 % SO_3 Benefited by Special Manuring with Sulphates?

BY

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Soils containing less than 0.02 % SO_3 are rather frequent and since such soils occur in Japan, it has some value to decide whether sulphates would considerably increase the yields by furnishing easily assimilable sulphur for protein formation. I selected for my test three soils which gave the following numbers on analysis[1]:

	CaO.	MgO.	P_2O_5.	SO_3.
I.	0.153 %	0.092 %	0.025 %	0.016 %
II.	0.028 „	0.118 „	0.022 „	0.013 „
III.	0.093 „	0.035 „	0.017 „	0.010 „

No. I came from Sakamura in Hiroshima Prefecture and was a sandy loam; No. II came also from Heira-Mura in the same Prefecture and was a clayey soil; and No. III came from Hirono-Mura in Fukushima Prefecture and was also of a clayey nature.

Seventy-two zinc pots containing 13, 14 and 11 Kg soils resp. served for this experiment, three pots for each trial. The general manure per pot for these three soils was:

Sodium nitrate... ... ... 6 g, in two fractions.
Double superphosphate[2]... ... ... 3 g
Potassium carbonate ... ... 2.5 g

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1). The analysis was carried out according Ulbricht's method with a hydrochloric acid of 10 %, a little modified by T. Katayama.

2). Only the soluble portion of this preparation served for this experiment and contained 36.76 % P_2O_5, 0.81 % CaO and 0.83 % SO_3 in the original sample.

In every case also an experiment without general manure was made in order to observe principally the effects of the sulphates added on the condition of the soil, since, especially with clayey and humus soils, the effects on the soils have to be well distinguished from the effects on the plants. Gypsum, magnesium sulphate and sodium sulphate may be able to liberate potassa from hydrous silicates and render it more available to the plants.

With the soil No. I and No. III the lime content was larger than the magnesia content and since barley was to be grown the manuring with magnesia might benefit the barley. In these cases the sulphate was applied in the form of crystallized magnesium sulphate. Further for sake of comparison, magnesia was also applied as magnesite with and without sodium sulphate (equivalent to $MgSO_4$).

In the case of the soil No. II there was more magnesia present than lime, hence the sulphate applied was $CaSO_4.2H_2O$. Control pots contained either limestone or limestone and sodium sulphate. The following table will show the quantities applied per pot:

Kind of Manures.	Soil No. I.	Soil No. II.	Soil No. III.
$MgSO_4.7H_2O$	1.61 g[1]	———	1.30 g[1]
Magnesite	16.51 „	———	13.29 „
$CaSO_4.2H_2O$	———	9.68 g[2]	———
$CaCO_3$	———	16.88 „[2]	———
„	———	22.50 „[3]	———
$Na_2SO_4.10H_2O$	2.11 g	18.13 „	1.70 g

Thirty-one seeds p. pot were sown Nov. 29, 1904 and the young plants of about 6 cm. height were reduced to 22, 17 and 21 resp. in the three different soils. The height of plants measured April 8 may be seen in the following table:

1). The MgO plied as sulphate corresponds to 1/30 of the calculated amount of MgO as magnesite.

2). These amounts were applied to the second series of soil No. II pot (2), 1/4 of the calculated amount of CaO being applied as $CaSO_4.2H_2O$ (cf. this Bulletin Vol. I, No. 1, p. 28).

3). This amount was applied to the third series of the soil II.

Soil No. I.

Kinds of manure.	A). Without general manure.		B). With general manure.	
	Height of plants.		Height of plants.	
	of each pot. cm.	average. cm.	of each pot. cm.	average. cm.
1) No special manure ... ... a.	51.5	53.1	66.0	65.7
b.	56.5		66.6	
c.	51.6		64.5	
2) $MgSO_4.7H_4O$ ... ... a.	49 2	51.9	69 0	66.7
b.	58.5		67.5	
c.	48 0		63.6	
3) Magnesite ... ... a.	53.1	52.9	63.9	66.5
b.	53.1		68.1	
c.	52.5		67.5	
4) Magnesite + Na_2SO_4 $10H_2O$. a.	55.2	51.4	64.5	63.9
b.	52.5		66.6	
c.	46.5		60.6	

Soil No. II.

Kinds of manure.	A). Without general manure.		B). With general manure.	
	Height of plants.		Height of plants.	
	of each pot. cm.	average. cm.	of each pot. cm.	average. cm.
1) No special manure ... ... a.	3.9	4.4	32.1	32.5
b.	4.5		32.4	
c.	4 8		33.0	
2) Gypsum + Lime-stone ... a.	9 6	8 6	48 0	48.6
b.	9.9		51.6	
c.	6 3		46.2	

Kinds of manure.		A). Without general manure. Height of plants. of each pot. cm.	A). Without general manure. Height of plants. average. cm.	B). With general manure. Height of plants. of each pot. cm.	B). With general manure. Height of plants. average. cm.
3) Limestone	a.	11.1	12.0	51.0	51.0
	b.	11.4		52.5	
	c.	13.5		49.5	
4) Limestone + $Na_2SO_4.10H_2O$.	a.	8.1	9.6	46.5	49 7
	b.	10.2		52.5	
	c.	10.5		50.1	

Soil No. III.

Kinds of manure.		A). Without general manure. Height of plants. of each pot. cm.	A). Without general manure. Height of plants. average. cm.	B). With general manure. Height of plants. of each pot. cm.	B). With general manure. Height of plants. average. cm.
1) No special manure ...	a.	24.9	26.1	57 6	58.9
	b	28.8		56.1	
	c.	24.6		63.0	
2) $MgSO_4.7H_2O$	a.	24.6	23.9	62.1	59 6
	b.	22.5		57.0	
	c.	24.6		——	
3) Magnesite	a.	18.6	20.4	57.0	58.8
	b.	27.9		59 4	
	c.	20.7		60.0	
4) Magnesite + $Na_2SO_4.10H_2O$.	a.	25.5	26.5	61.8	58.3
	b.	26.1		58.5	
	c.	27.9		54.6	

Plants were cut on June 10 and the harvest was weighed in the air-dry state with the following result:

No. I. Hiroshima soil (a).

(A.) Without general manure.

Kinds of manure.	No. of stalks.	Length of stalks cm.	Weight p. pot of				Average of	
			Grains g	Stalks g	Chaff g	Total g	Grains g	Total g
1) No special manure a.	32	93.0	28.88	50.25	3.00	82.13		
1) No special manure b.	39	97.8	25.50	59.25	2.63	87.38	26.91	85.54
1) No special manure c.	33	94.5	26.36	49.13	2.63	78.12		
2) $MgSO_4.7H_2O$.. a.	28	96.0	22.05	48.75	1.50	72.30		
2) $MgSO_4.7H_2O$.. b.	22	96.0	16.58	35.63	1.13	53.34	21.13	66.51
2) $MgSO_4.7H_2O$.. c.	25	88.2	24.75	46.50	2.63	73.88		
3) Magnesite ... a.	26	88.2	20.25	46.88	2.63	69.76		
3) Magnesite ... b.	29	95.1	19.13	56.25	3.00	78.38	22.13	76.38
3) Magnesite ... c.	30	96.0	27.00	51.00	3.00	81.00		
4) Magnesite + $Na_2SO_4.10H_2O$ a.	33	98.4	26.63	57.00	3.38	87.01		
4) Magnesite + $Na_2SO_4.10H_2O$ b.	29	98.1	24.75	53.25	3.38	81.38	27.63	86.51
4) Magnesite + $Na_2SO_4.10H_2O$ c.	35	90.0	31.50	55.50	4.13	91.13		

(B.) With general manure.

Kinds of manure.	No. of stalks.	Length of stalks cm.	Weight p. pot of				Average of	
			Grains g	Stalks g	Chaff g	Total g	Grains g	Total g
1) No special manure a.	61	100.8	68.25	106.88	6.75	181.88		
1) No special manure b.	61	114.0	63.38	104.25	6.38	174.01	64.75	176.13
1) No special manure c.	64	111.0	62.63	104.63	5.25	172.51		
2) $MgSO_4.7H_2O$.. a.	59	106.2	69.75	114.00	6.00	189.75		
2) $MgSO_4.7H_2O$.. b.	59	112.5	60.75	106.50	5.25	172.50	66.63	181.00
2) $MgSO_4.7H_2O$.. c.	61	101.4	69.38	105.38	6.00	180.76		

Kinds of manure.	No. of stalks.	Length of stalks cm.	Weight p. pot of Grains g	Stalks g	Chaff g	Total g	Average of Grains g	Total g
3) Magnesite ... a.	63	101.7	69.00	111.38	6.75	187.13		
b.	60	105.6	68.25	111.00	7.13	186.38	69.13	187.13
c.	64	108.1	70.13	111.38	6.38	187.89		
4) Magnesite + $Na_2SO_4.10H_2O$ a.	66	109.5	59.25	100.13	5 63	165.01		
b.	60	100.4	69.38	107.25	6.38	183.01	63.88	173.51
c.	58	107.1	63.00	103.50	6.00	172.50		

No. II. Hiroshima soil (b).

(A). Without general manure.

Kinds of manure.	No. of stalks.	Length of stalks cm.	Weight p. pot of Grains g	Stalks g	Chaff g	Total g	Average of Grains g	Total g
1) No special manure a.	13	14.4	0	0.38	0	0.38		
b.	15	17.1	0	0 75	0	0 75	0	2.00
c.	16	17.4	0	4.88	0	4.88		
2) Gypsum + Limestone 1) a.	—	—	—	—	—	—		
b.	18	27 3	0.15	3.00	0.05	3.20	0.27	4.51
c.	18	26.4	0.38	2.63	0.18	5.81		
3) Limestone ... a.	22	26.0	1.13	5.25	0.38	6.76		
b.	21	33.3	1.13	4.88	0.38	6.39	1.13	6.64
c.	19	36.2	1.13	5.25	0.38	6.76		
4) Limestone + $Na_2SO_4.10H_2O$ a.	14	32.1	0.38	4.13	0.18	4 69		
b.	16	31.5	0.75	4.88	0.38	6.01	0.50	4.75
c.	14	29.1	0.38	3.00	0.18	3.56		

1). Plants in this pot were attacked by fungus.

(B). With general manure.

Kinds of manure.		No. of stalks.	Length of stalks cm.	Weight p. pot of Grains g	Stalks g	Chaff g	Total g	Average of Grains g	Total g
1) No special manure	a.	29	57.9	1.13	31.88	0.75	33.76		
	b.	30	79.5	1.88	35.25	0.75	37.88	1.25	35.13
	c.	32	60.6	0.75	32.63	0.38	33.76		
2) Gypsum + Limestone	a.	47	87.9	32.25	66.75	3.38	102.38		
	b.	46	91.8	35.25	64.50	4.13	103.88	34.63	104.01
	c.	42	87.0	36.38	64.50	4.88	105.76		
3) Limestone[1] ...	a.	44	90.0	35.25	69.38	3.38	108.01		
	b.	45	99.0	36.75	67.50	4.50	108.75	38.63	112.51
	c.	46	94.2	43.88	70.88	6.00	120 76		
4) Limestone + $Na_2SO_4.10H_2O$	a.	44	93.0	31.50	62.25	4.13	97.88		
	b.	55	94.5	48.75	76.50	5.25	130.50	41.63	116.38
	c.	49	90.0	44.63	71.25	4.88	120.76		

No. III. Fukushima soil.

(A). Without general manure.

Kinds of manure.		No. of stalks.	Length of stalks cm.	Weight p. pot of Grains g	Stalks g	Chaff g	Total g	Average of Grains g	Total g
1) No special manure	a.	22	57.0	10.13	14.63	1.50	26.26		
	b.	21	59.4	10.13	15.75	1.50	27.38	10.00	26.38
	c.	21	62.1	9.75	14.25	1.50	25.50		
2) $MgSO_4.7H_2O$..	a.	21	56.4	7.88	13.88	1.13	22.89		
	b.	22	57.9	8.63	15.38	1.50	25.51	7.75	24.26
	c.	24	46.5	6.75	16.13	1.50	24.38		

1). A part of this increase by limestone may be due to the improvement of the mechanical condition of the clay soil. Further communication on this effect will follow later on.

Kinds of manure.		No. of stalks.	Length of stalks cm.	Weight p. pot of Grains g	Stalks g	Chaff g	Total g	Average of Grains g	Total g
3) Magnesite ...	a.	18	56.4	7.13	12.75	1.50	21.38	8.25	23.76
	b.	23	60.0	10 50	15.00	1.13	26.63		
	c.	21	57.3	7.13	14.63	1.50	23.26		
4) Magnesite + $Na_2SO_4.10H_2O$	a.	21	66.9	11.63	16.88	1.50	30 01	10.13	28.01
	b.	21	58.5	9.75	15.38	3.38	28.51		
	c.	20	57.6	9 00	15.00	1.50	25.50		

(B). With general manure.

Kinds of manure.		No. of stalks.	Length of stalks cm.	Weight p. pot of Grains g	Stalks g	Chaff g	Total g	Average of Grains g	Total g
1) No special manure	a.	57	97.2	57.00	97.88	7.13	126.01	52.75	138.26
	b.	58	97.5	52.13	85.50	4.88	142.51		
	c.	61	95.4	49.13	95.25	4.88	149.26		
2) $MgSO_4.7H_2O$..	a.	65	95.1	48.38	95.25	5.25	148.88	50.44	149.07
	b.	60	93.0	52.50	91.50	5.25	149.25		
	c. [1]	—	—	—	—	—	---		
3) Magnesite ...	a.	62	87.0	53.63	91.88	6 38	151.89	47.50	147.26
	b.	60	90.0	45.38	94.88	5.25	145.51		
	c.	56	97.5	43.50	95.63	5.25	144.38		
4) Magnesite + ... $Na_2SO_4.10H_2O$	a.	73	95.4	49.13	99.75	7.88	156.76	49.50	146.76
	b.	64	97.5	50.25	87.00	6.38	143.63		
	c.	58	99.0	49.13	86.25	4.50	139.88		

1). The plants in this pot were damaged by fungus.

From these results we conclude :

1). An amount less than 0.02 % SO_3 in the three soils was quite sufficient to meet the requirements of the barley plants for sulphur. The difference in the harvests was too small to admit any other conclusion than this.

2). In the soil No. I and No. III the manuring with magnesia had no decisive effect; this may have been due to the small differences of lime and magnesia contents in these soils.

3). Soil No. II[1] showed a very unfavorable mechanical condition being a very stiff clay and was probably very poor in potassa[2], while the amount of P_2O_5 was only 0.022%. Hence the addition of limestone to the un-manured soil had very little effect although the mechanical condition was improved, while with the manured soil the addition of limestone produced a surprising increase of barley grains from 1.25 g to 38.63 g.

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1). This soil was found afterwards to have a strong acid reaction on litmus, and since this soil contains only a little humus, the acidity would probably be due to acid silicates. Enormous increase of harvest by liming of this soil is therefore partly explained by the neutralization of the acidity. Many such acid soils occur in Japan and the result of investigation of these soils will be published later on.

2). A sample of soil taken from the same area contained only 0.088% K_2O.