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New Experiments with Fungicides
for Smuts of Wheat and Oats.

BY W. A. KELLERMAN.





NEW EXPERIMENTS WITH FUNGICIDES FOR SMUT OF WHEAT AND OATS.

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The hot-water method of treatment of seed to prevent smut of oats and wheat has since its introduction by Jensen, in 1888, proven thoroughly efficient and entirely satisfactory to experimenters. The favorable results published in the Kansas Experiment Station bulletins by myself and Mr. Swingle in the year 1889, also in 1890 and '91, and by Arthur in the Indiana bulletins in 1890 and subsequently, have since been corroborated by very many experimenters and by some farmers.

But we have to make the same complaint here that Jensen has already made in Denmark, namely, that comparatively few farmers seem inclined to put the method into practice.

The advantages of applying this treatment, insuring as it does an increase in the crop not only by replacing the smutted by sound heads (which would be a gain generally from five to fifteen per cent. or more), but also by an extra yield of perhaps five per cent. additional to the increase just mentioned, would seem to be so apparent and convincing to every farmer, that, unless something connected with the manipulation deterred, the practice recommended should obtain quite generally, if not universally. The wide distribution of station bulletins and extended circulation of agricultural journals has surely made the method generally known.

The evident disinclination on the part of the ordinary farmer to adopt the practice is, I think, largely due to the fact that the imagined difficulty of heating water to a certain temperature measured by a thermometer, is very great, though of course trial would dispel the illusion. The suggestion—that raising the temperature to about 132° or 133° F., and maintaining that within about two degrees, by pouring in hot or cool water as needed, would seem difficult to a farmer; but that raising it to 140° and letting it gradually descend ten degrees, would be simple—seems not to have been well founded. At any rate, during the past two years the practice of applying this treatment has not, so far as I can determine, been gaining rapidly among the farmers.

An efficient treatment that would be perhaps somewhat simpler, not involving the use of the thermometer, or any other piece of

apparatus or appliance that the farmer is not in contact with every day, would doubtless more readily penetrate the conservatism of the average tiller of the soil, and be even more acceptable to the progressive agriculturist.

Potassium Sulphide an Efficient Fungicide.

Such an improved treatment is doubtless to be found in the use of potassium sulphide (liver of sulphur), first used for this purpose in 1890 by Mr. Swingle and myself. The experiments have been repeated since by very few persons, so far as I know. I took the opportunity during the season just past to carry out some new experiments, having in mind above all, the desirability of a better method of application of this fungicide. At the same time I have made some comparisons of the efficiency of the following:—potassium sulphide, iron chloride and copper sulphate.

A summary tabulation of the results by treatment ranging from ten minutes to two hours, and with five per cent., three per cent. and one per cent. solutions, is as follows:

COMPARISON OF SMUT PERCENTAGES IN THE CROP OF OATS FROM SEED TREATED WITH VARIOUS SOLUTIONS OF THREE FUNGICIDES.

Fungicide.	Five per cent.	Three per cent.	One per cent.	Average.
Potassium sulphide.....	0.22	0.80	1.80	1.00
Iron chloride	3.45	3.58	12.42	6.18
Copper sulphate.....	0.74	0.58		0.65
Seed untreated				17.71

It is noticed that while potassium sulphide is a satisfactory fungicide, the iron chloride is much inferior, though, of course, materially reducing the quantity of smut; and copper sulphate is the most efficient of the three. But the use of the latter fungicide injured the seed very much; in case of some of the plots a yield less than one-eighth of an average crop was obtained. These results are in accord with those reported by all experimenters. Copper sulphate is therefore to be most emphatically condemned. The germinations of the seed and character of the crop were entirely satisfactory in case of treatments with potassium sulphide and iron chloride.

Percentage solution and time of immersion.—A solution to be efficient, need not be stronger than five per cent. nor weaker

than three per cent. as indicated by the limited experiments. The time of immersion need not exceed one hour, and may, perhaps, satisfactorily continue but half an hour. A full and detailed statement of the experiments may be found in the appendix to this paper. Here is given a portion of the tabulation to illustrate the statements made.

PERCENTAGE OF SMUT IN THE CROP OF OATS FROM SEED TREATED WITH POTASSIUM SULPHIDE.

Time of immersion.	Five per cent. solution.	Three per cent. solution.	One per cent. solution.
Two hours.....	0.44	0.32	0.78
One hour.....	0.00	0.00	1.95
Thirty minutes.....	0.02	0.60	1.87
Ten minutes.....	0.11	1.12	2.00
Smut from untreated seed.....			17.71

PERCENTAGE OF SMUT IN THE CROP OF OATS FROM SEED TREATED WITH IRON CHLORIDE.

Time of immersion.	Five per cent. solution.	Three per cent. solution.	One per cent. solution.
Two hours.....	0.02	0.83	6.06
One hour.....	0.94	0.33	7.55
Thirty minutes.....	1.73	1.80	11.88
Ten minutes.....	1.10	6.81	19.24
Smut from untreated seed.....			17.71

The variation in the results is greater than would be anticipated, but larger plots and repetitions will doubtless eliminate such irregularities. The superiority of the potassium sulphide over the iron chloride treatment is quite marked. With it even a one per cent. solution with an immersion of two hours, would, as a farmer would say, "practically destroy the smut."

Method of application.—The treatment recommended in 1890 proved unsatisfactory, because of the difficulty of drying the grain after prolonged immersion. But the absorption of water during one or two hours is not large in amount, and the difficulty of drying the seed is not great, provided one has a floor space of suitable area. The seed may be several inches deep and yet dry

in a comparatively short time, if frequently turned with the shovel. A farmer would need no special instruction for applying this fungicide. A tub, a hogshead sawed in two, or any other wooden vessel could be used. The number of gallons of water desired (for example, 25 gals.) would be provided and to this the required number of pounds (2 lbs. for a one per cent. solution, twice as much for a two per cent. solution, three times as much for a three per cent. solution, and so on) would be added. In a few minutes, or perhaps an hour, if the quantity of the sulphide is large, the solution is ready for use. The seed should be stirred a few times while in the solution. The farmer's ingenuity will suggest the best method of making the immersion—whether to put the seed in a sack of coarse cloth, in a basket or frame covered with wire gauze, or directly in the watery solution; and whether the solution can be more conveniently poured off or removed by a faucet, etc.

Is washing the seed desirable?—The suggestion has doubtless come to many or all that thorough washing the seed would remove not only most of the smutted grains and smut mixed in the mass, but perhaps also the adhering smut spores, through which we know infection occurs, in case of oat smut, barley smut and stinking smut of wheat. I have put this theory to the test, as can be seen by consulting the appended full tabulation. So far as oats is concerned, the following table shows that no advantage results from such a practice, but on the contrary more smutted heads occur:

PERCENTAGE OF SMUT IN THE CROP FROM UNTREATED SEED AND WASHED SEED.

Seed untreated.....	16.74 per cent.
Seed untreated but washed	18.51 “

The above statement is based on a count of 17,757 heads, distributed in 24 different plots.

May seed be washed after treatment? Were it allowable to wash seed after the treatment with a fungicide, the handling of the seed would be less disagreeable, and the drying would be more easily accomplished. I have accordingly sought to decide the question experimentally and the following tabulation shows the result:

PERCENTAGE OF SMUT IN THE CROP OF OATS WHEN THE SEED IS WASHED AFTER TREATMENT.

Fungicide and time of immersion	Five per cent solution.		Three per cent. solution.		One per cent. solution.	
	Not washed	Wash'd	Not washed	Wash'd	Not washed	Wash'd
Potassium sulphide, two hours..	0.44	0.00	0.32	0.68	0.78	1.33
Potassium sulphide, one hour...	0.00	0.00	0.00	1.40	1.95	2.89
Iron chloride, two hours.	0.02	6.46	0.83	6.23	6.06	13.11
Iron chloride, one hour	0.94	3.84	0.33	6.17	7.55	15.86
Copper sulphate, one hour.....	0.00	3.10	0.37	1.82		

It is evident that removing the adhering solution from the seed, instead of allowing it to dry without washing, makes the treatment less efficient. The result of all the tests, except the first, is uniform. The discrepancy in case of the potassium sulphide treatment, five per cent. solution, is unaccounted for and perhaps accidental. Washing the seed after treatment is without doubt undesirable.

Ceres-pulver a Substitute for Ordinary Potassium Sulphide.

A coarsely granular form of potassium sulphide to which other ingredients are added, originated by J. L. Jensen, is now offered for sale in the market under the name of "Ceres pulver." It is to be dissolved in water and the solution poured on the grain with an ordinary watering can used by florists. Two hundred grams dissolved in 25 liters of water (about 6 ounces in 6 gallons) suffices for two hundred pounds of grain. In a single trial with the ceres-pulver, I obtained the following result :

PERCENTAGE OF SMUT IN THE CROP OF OATS FROM SEED TREATED WITH CERES-PULVER.

Seed treated with ceres-pulver	1.80
Seed untreated	17.71

The large amount of smut in the crop of oats generally in this region, the present season, and especially in the plats planted for comparison (nearly 18 per cent.), gives the test, though a single one, considerable significance. As seen, the smut is less than two per cent.—a reduction that would be designated in common parlance as "practical destruction" of the smut. The method of treatment is simple, carried out with little labor and *I would recommend its adoption*. Jensen directs that the grain be put on

tight floors, the solution be poured on with vigorous and repeated shovelling, so that all of the grain will come in contact with the solution. While drying, the mass should not be over six or eight inches deep and shovelled over at least twice daily. The seed is to be sowed not earlier than three days after the treatment, better 4 or 5 days, the initial germination in the meantime regarded as beneficial rather than otherwise.

Jensen's Method Applied with other Fungicides.

The method of treatment recommended for the *ceres-pulver* when applied to the fungicides discussed above, does not seem to be so effectual as the immersion for a period of time, though as the annexed table shows the amount of smut is materially reduced :

PERCENTAGE OF SMUT IN THE CROP OF OATS FROM SEED TREATED ACCORDING TO JENSEN'S METHOD, THAT IS, SPRINKLING WITH THE SOLUTION.

Solution used.	Five per cent.	Three per cent.
Potassium sulphide	1.52	5.38
Iron chloride.....	4.88	10.12
Copper Sulphate..	1.60	0.85
Seed untreated, per cent	17.71	

Experiments with Wheat.

The above relates to experiments with oats the present season, April-July, 1896. Experiments with wheat, somewhat similar, begun in the autumn of 1895, have proven very unsatisfactory by reason of partial failure of the wheat crop and the small amount of smut this season. The tabulation of the tests, however, is appended since they in a general way, corroborate the satisfactory results obtained with oats. Copper sulphate proved, as on all other occasions, to be destructive to smut, also more or less strikingly so to the wheat, therefore never to be recommended. The potassium sulphide, according to results obtained, is satisfactory and preferable to iron chloride.

Appendix.

I. OATS.

TABULATION SHOWING THE ARRANGEMENT OF THE PLOTS, THE NUMBER OF HEADS COUNTED, THE NUMBER AND PERCENTAGE OF SMUTTED HEADS. (Nos. 1-65 planted April 11; Nos. 66-79 planted April 18.)

Plot.	Treatment of seed.	Heads counted.	Heads smutted.	Per cent. smutted.
1	Untreated.....	445	60	13.48
2	Untreated but washed.....	682	81	11.88
3	K ₂ S, 5%, 2 hours.....	459	2	0.44
4	K ₂ S, 5%, 1 hour.....	491	0	0
5	K ₂ S, 5%, 30 min.....	443	1	0.02
6	K ₂ S, 5%, 10 min.....	278	3	0.11
7	K ₂ S, 5%, 2 hours, washed.....	525	0	0
8	K ₂ S, 5%, 1 hour washed.....	563	0	0
9	Untreated.....	582	134	23.02
10	Untreated but washed.....	720	112	15.56
11	FeCl ₃ , 5%, 2 hours.....	576	1	0.02
12	FeCl ₃ , 5%, 1 hour.....	854	8	0.94
13	FeCl ₃ , 5%, 30 min.....	462	8	1.73
14	FeCl ₃ , 5%, 10 min.....	817	9	1.10
15	FeCl ₃ , 5%, 2 hours, washed.....	758	49	6.46
16	FeCl ₃ , 5%, 1 hour, washed.....	826	72	8.84
17	Untreated.....	476	76	15.97
18	Untreated but washed.....	1010	217	21.49
19	Cu SO ₄ , 5%, 2 hours, [seed injured].....	145	0	0
20	Cu SO ₄ , 5%, 1 hour, [seed injured].....	249	0	0
21	Cu SO ₄ , 5%, 10 min., [seed injured].....	220	0	0
22	Cu SO ₄ , 5%, 2 hours, washed [seed injur'd]	211	0	0
23	Cu SO ₄ , 5%, 1 hour, washed [seed injured]	258	8	3.10
24	Untreated.....	559	97	17.35
25	Untreated but washed.....	805	151	18.77
26	K ₂ S, 3%, 2 hours.....	616	2	0.32
27	K ₂ S, 3%, 1 hour.....	663	0	0.00
28	K ₂ S, 3%, 30 min.....	503	3	0.60
29	K ₂ S, 3%, 10 min.....	708	8	1.12
30	K ₂ S, 3%, 2 hours, washed.....	444	3	0.68
31	K ₂ S, 3%, 1 hour, washed.....	716	10	1.40
32	Untreated.....	461	131	28.42
33	Untreated but washed.....	773	121	15.65
34	FeCl ₃ , 3%, 2 hours.....	724	6	0.83
35	FeCl ₃ , 3%, 1 hour.....	602	2	0.33
36	FeCl ₃ , 3%, 30 min.....	665	12	1.80
37	FeCl ₃ , 3%, 10 min.....	440	30	6.81
38	FeCl ₃ , 3%, 2 hours, washed.....	738	46	6.23
39	FeCl ₃ , 3%, 1 hour, washed.....	681	42	6.17
40	Untreated.....	405	67	16.54
41	Untreated but washed.....	872	206	23.62
42	Cu SO ₄ , 3%, 2 hours, [seed injured].....	95	0	0.00
43	Cu SO ₄ , 3%, 1 hour, [seed injured].....	207	0	0.00
44	Cu SO ₄ , 3%, 30 min., [seed injured].....	258	0	0.00
45	Cu SO ₄ , 3%, 10 min., [seed injured].....	320	1	0.31
46	Cu SO ₄ , 3%, 2 hours, washed [seed injur'd]	271	1	0.37
47	Cu SO ₄ , 3%, 1 hour, washed, [seed injured]	389	7	1.82

I. OATS.—*Concluded.*

TABULATION SHOWING THE ARRANGEMENT OF THE PLOTS, THE NUMBER OF HEADS COUNTED, THE NUMBER AND PERCENTAGE OF SMUTTED HEADS. (Nos. 1-65, planted April 11; Nos. 66-79, planted April 18.)

Plots.	Treatment of seed.	Heads counted.	Heads smutted.	Per cent. smutted.
48	Untreated.....	686	143	20.85
49	Untreated but washed	853	242	28.34
50	K ₂ S, 1%, 2 hours.....	637	5	0.78
51	K ₂ S, 1%, 1 hour.....	512	10	1.95
52	K ₂ S, 1%, 30 min.....	643	12	1.87
53	K ₂ S, 1%, 10 min.....	499	10	2.00
54	K ₂ S, 1%, 2 hours, washed.....	603	8	1.33
55	K ₂ S, 1%, 1 hour, washed.....	657	19	2.89
56	Untreated.....	583	105	18.01
57	Untreated but washed	647	139	21.17
58	FeCl ₃ , 1%, 2 hours.....	578	35	6.06
59	FeCl ₃ , 1%, 1 hour.....	530	40	7.55
60	FeCl ₃ , 1%, 30 min.....	488	58	11.88
61	FeCl ₃ , 1%, 10 min.....	603	116	19.24
62	FeCl ₃ , 1%, 2 hours, washed.....	720	94	13.11
63	FeCl ₃ , 1%, 1 hour, washed.....	599	95	15.86
64	Untreated.....	562	88	15.66
65	Untreated but washed	470	83	17.66
66	Untreated.....	905	103	11.38
67	Untreated but washed	1015	154	15.17
68	K ₂ S, 5%, Jensen method of application....	1118	17	1.52
69	FeCl ₃ , 5%, Jensen method of application ..	1045	51	4.88
70	Cu SO ₄ , 5%, Jensen method [seed injured]	439	7	1.60
71	Untreated.....	1106	111	10.03
72	Untreated but washed	754	163	21.62
73	K ₂ S, 3%, Jensen method of application....	985	51	5.38
74	FeCl ₃ , 3%, Jensen method of application ..	949	96	10.12
75	Cu SO ₄ , 3%, Jensen method [seed injured]	820	7	0.85
76	Untreated.....	1043	127	12.18
77	Untreated but washed	1040	134	12.88
78	Ceres-pulver (Jensen's).....	1093	19	1.80
79	Untreated.....	1002	100	9.98
Average percentage of smut in untreated plots.....				17.71

II. WHEAT.

TABULATION SHOWING THE ARRANGEMENT OF THE PLOTS, THE NUMBER OF HEADS COUNTED, THE NUMBER AND PERCENTAGE OF SMUTTED HEADS.

Plot.	Treatment of seed.	Heads counted.	Heads smutted.	Per cent. smutted.
80	Untreated.....	2512	81	3.22
81	K ₂ S, 5 per cent., 1 hour, limed.....	210	0	0.00
82	FeCl ₃ , 5 per cent., 1 hour, limed.....	471	1	0.21
83	K ₂ S, 5 per cent., 1 hour.....	230	0	0.00
84	FeCl ₃ , 5 per cent., 1 hour.....	326	1	0.31
85	Water, 20 min., changed.....	570	10	1.75
86	K ₂ S, 5 per cent., 30 min., limed.....	347	1	0.29
87	FeCl ₃ , 5 per cent., 30 min., limed.....	473	1	0.21
88	K ₂ S, 5 per cent., 30 min.....	578	0	0.00
89	FeCl ₃ , 5 per cent., 30 min.....	553	2	0.36
90	Water, 30 min.....	835	17	2.04
91	Water, 30 min., changed.....	532	2	0.39
92	K ₂ S, 5 per cent., 20 min., limed.....	625	0	0.00
93	FeCl ₃ , 5 per cent., 20 min., limed.....	513	2	0.39
94	K ₂ S, 5 per cent., 20 min.....	578	0	0.00
95	FeCl ₃ , 5 per cent., 20 min.....	497	0	0.00
96	K ₂ S, 5 per cent., 10 min., limed.....	560	0	0.00
97	FeCl ₃ , 5 per cent., 10 min., limed.....	520	0	0.00
98	K ₂ S, 5 per cent., 10 min.....	437	0	0.00
99	FeCl ₃ , 5 per cent., 10 min.....	600	0	0.00
100	Water, 10 min., limed.....	647	0	0.00
101	Water, 10 min., changed.....	466	6	4.72
102	Untreated.....	835	48	5.75
103	K ₂ S, 4 per cent., 1 hour, limed.....	297	0	0.00
104	FeCl ₃ , 4 per cent., 1 hour, limed.....	564	3	0.53
105	K ₂ S, 4 per cent., 1 hour.....	319	0	0.00
106	FeCl ₃ , 4 per cent., 1 hour.....	468	0	0.00
107	K ₂ S, 4 per cent., 30 min., limed.....	393	0	0.00
108	FeCl ₃ , 4 per cent., 30 min., limed.....	256	0	0.00
109	K ₂ S, 4 per cent., 30 min.....	243	1	0.41
110	FeCl ₃ , 4 per cent., 30 min.....	441	0	0.00
111	K ₂ S, 4 per cent., 20 min.....	324	0	0.00
112	FeCl ₃ , 4 per cent., 20 min.....	392	0	0.00
113	K ₂ S, 4 per cent., 10 min.....	300	0	0.00
114	FeCl ₃ , 4 per cent., 10 min.....	296	1	0.34
115	Untreated.....	881	36	4.09
116	Water, 1 hour.....	427	4	0.94
117	Water, 1 hour, changed.....	510	1	0.20
118	K ₂ S, 3 per cent., 1 hour.....	225	0	0.00
119	FeCl ₃ , 3 per cent., 1 hour.....	312	0	0.00
120	K ₂ S, 3 per cent., 30 min.....	354	0	0.00
121	FeCl ₃ , 3 per cent., 30 min.....	352	0	0.00
122	K ₂ S, 3 per cent., 20 min.....	306	2	0.65
123	FeCl ₃ , 3 per cent., 20 min.....	338	1	0.29
124	K ₂ S, 3 per cent., 10 min.....	297	0	0.00
125	FeCl ₃ , 3 per cent., 10 min.....	428	0	0.00
126	K ₂ S, 2 per cent., 1 hour.....	346	0	0.00
127	FeCl ₃ , 2 per cent., 1 hour.....	313	0	0.00
128	K ₂ S, 2 per cent., 30 min.....	259	0	0.00

II. WHEAT.—Continued.

TABULATION SHOWING THE ARRANGEMENT OF THE PLOTS, THE NUMBER OF HEADS COUNTED, THE NUMBER AND PERCENTAGE OF SMUTTED HEADS.

Plot.	Treatment of seed.	Heads counted.	Heads smutted.	Per cent. smutted.
129	FeCl ₃ , 2 per cent., 30 min.	318	0	0.00
130	K ₂ S, 2 per cent., 20 min.	297	0	0.00
131	FeCl ₃ , 2 per cent., 20 min.	582	0	0.00
132	K ₂ S, 2 per cent., 10 min.	546	2	0.37
133	FeCl ₃ , 2 per cent., 10 min.	581	3	0.52
134	Water, 20 min.	404	2	0.50
135	Water, 20 min., changed, limed.	362	1	0.28
136	Untreated.	1128	68	6.03
137	K ₂ S, 1 per cent., 1 hour, limed.	415	3	0.72
138	FeCl ₃ , 1 per cent., 1 hour, limed.	303	0	0.00
139	K ₂ S, 1 per cent., 1 hour.	206	3	1.46
140	FeCl ₃ , 1 per cent., 1 hour.	308	1	0.32
141	K ₂ S, 1 per cent., 30 min., limed.	474	0	0.00
142	FeCl ₃ , 1 per cent., 30 min., limed.	371	6	1.62
143	K ₂ S, 1 per cent., 30 min.	225	0	0.00
144	FeCl ₃ , 1 per cent., 30 min.	321	2	0.62
145	K ₂ S, 1 per cent., 20 min., limed.	373	0	0.00
146	FeCl ₃ , 1 per cent., 20 min., limed.	273	2	0.73
147	K ₂ S, 1 per cent., 20 min., limed.	309	6	1.94
148	FeCl ₃ , 1 per cent., 20 min., limed.	411	1	0.24
149	K ₂ S, 1 per cent., 20 min.	318	0	0.00
150	FeCl ₃ , 1 per cent., 20 min.	276	2	0.72
151	K ₂ S, 1 per cent., 10 min.	214	0	0.00
152	FeCl ₃ , 1 per cent., 10 min.	449	0	0.00
153	Water, 10 min.	460	4	0.87
154	Water, 10 min., changed.	248	3	1.21
155	Untreated.	965	59	1.11
156	Cu SO ₄ * 5 per cent., 1 hour, limed.	298	1	6.34
157	Cu SO ₄ , 5 per cent., 1 hour.	59	0	0.00
158	Cu SO ₄ , 5 per cent., 30 min., limed.	254	1	0.43
159	Cu SO ₄ , 5 per cent., 30 min.	192	1	0.52
160	Cu SO ₄ , 5 per cent., 20 min., limed.	377	1	0.27
161	Cu SO ₄ , 5 per cent., 20 min.	81	0	0.00
162	Cu SO ₄ , 5 per cent., 10 min., limed.	216	1	0.46
163	Cu SO ₄ , 5 per cent., 10 min.	198	0	0.00
164	Cu SO ₄ , 4 per cent., 1 hour, limed.	357	0	0.00
165	Cu SO ₄ , 4 per cent., 1 hour.	116	0	0.00
166	Cu SO ₄ , 4 per cent., 30 min., limed.	220	0	0.00
167	Cu SO ₄ , 4 per cent., 30 min.	111	0	0.00
168	Cu SO ₄ , 4 per cent., 20 min., limed.	267	0	0.00
169	Cu SO ₄ , 4 per cent., 20 min.	144	0	0.00
170	Cu SO ₄ , 4 per cent., 10 min., limed.	275	0	0.00
171	Cu SO ₄ , 4 per cent., 10 min.	224	0	0.00
172	Cu SO ₄ , 3 per cent., 1 hour.	122	0	0.00
173	Cu SO ₄ , 3 per cent., 30 min.	134	0	0.00
174	Cu SO ₄ , 3 per cent., 20 min.	173	0	0.00
175	Cu SO ₄ , 3 per cent., 10 min.	105	0	0.00
176	Water, 20 min., limed.	370	4	1.08

*Seed was injured by the Cu SO₄.

RELATION OF SEEDING TO

II. WHEAT.—*Concluded.*

TABULATION SHOWING THE ARRANGEMENT OF THE PLOTS, THE NUMBER OF HEADS COUNTED, THE NUMBER AND PERCENTAGE OF SMUTTED HEADS.

Plot.	Treatment of seed.	Heads counted.	Heads smutted.	Per cent. smutted.
177	Untreated.....	446	17	3.86
178	Cu SO ₄ , 2 per cent., 1 hour.....	279	1	0.36
179	Cu SO ₄ , 2 per cent., 30 min.....	275	0	0.00
180	Cu SO ₄ , 2 per cent., 20 min.....	234	0	0.00
181	Cu SO ₄ , 2 per cent., 10 min.....	201	0	0.00
182	Cu SO ₄ , 1 per cent., 1 hour, limed.....	238	0	0.00
183	Cu SO ₄ , 1 per cent., 1 hour.....	186	0	0.00
184	Cu SO ₄ , 1 per cent., 30 min., limed.....	271	0	0.00
185	Cu SO ₄ , 1 per cent., 30 min.....	294	0	0.00
186	Cu SO ₄ , 1 per cent., 20 min., limed.....	384	0	0.00
187	Cu SO ₄ , 1 per cent., 20 min.....	320	0	0.00
188	Cu SO ₄ , 1 per cent., 10 min., limed.....	290	1	0.34
189	Cu SO ₄ , 1 per cent., 10 min.....	340	0	0.00
190	Untreated.....	1005	63	6.27

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