EXPERIMENT STATION,

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BOTANICAL DEPARTMENT.

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PRELIMINARY EXPERIMENTS WITH FUNGICIDES FOR STINKING SMUT OF WHEAT.

In very many localities, in nearly every wheat-growing country, the crop is more or less injured and sometimes seriously damaged by a disease called "Stinking Smut," "Bunt," or simply "Smut." This disease is not detected until the plants have headed out, and even then it is often overlooked.

Before the grain ripens, a careful examination reveals the fact that certain heads have a dark, bluish-green color, while healthy plants present a lighter, yellowish-green color. During and after ripening of the grain, the smutted heads have a paler appearance than healthy ones. At no time do the smutted heads present the yellowish shade so characteristic of ripening wheat. When the smutted heads are examined it is found that the grains have become dark, and more or less swollen. (Plate I, figs. 5–8.*) They are at first of a greenish color, but become brownish or grayish when fully ripened. Because of their being usually swollen, the smutted grains push the chaff apart more than the sound kernels do, giving the head a slightly inflated and somewhat abnormal appearance. (Plate I, figs. 1 and 2.)

If one of the swollen smutted grains be crushed, it is found to be filled

*Plate I, figs. 5 and 6, show the entire swollen grains, and fig. 3 a sound grain. Figs. 7 and 8 give the appearance of the section of smutted grains, and fig. 4 of a sound grain. Figs. 3-8 represent the grains magnified about six diameters.

with a rather dull-brownish powder, which has a very disagreeable and penetrating odor.

Often the disease is not discovered till the grain is threshed, when it is recognized by the odor arising from the smutted grains crushed by the machine.

The smut may also be recognized during the milling, both from the odor arising during the grinding, and by the dark streaks found in the flour.

The dissemination of the disease is brought about by the use of smutted seed. The brown powder (smut) lodged in the threshing-machine may infect the seed, or the smut remaining in the field may, perhaps, through the soil, infect the succeeding crop.

AMOUNT OF DAMAGE.

The damage from stinking smut is often very considerable. It sometimes destroys from one-quarter to one-half of the crop, and besides renders the wheat unsalable and worthless for milling purposes.

Smutted wheat, if ground in the mill, injures a large quantity of flour subsequently made. The smut itself, or particularly the penetrating odor, is difficult to remove completely.

No exact counts have been made in fields in Kansas, but in our experimental plots planted November, 1889, with Kansas seed (untreated), the smut varied from *64 to 86 per cent.!*

CAUSE OF THE DISEASE.

The stinking smut was formerly supposed to be a diseased condition of the wheat plant caused by unfavorable conditions of soil or climate; but it has been demonstrated beyond the possibility of a doubt, that the disease is caused by a parasitic plant belonging to the group called FUNGI. This fungus grows within the wheat plant, and finally converts the nourishment intended for the production of the grain into a mass of exceedingly minute spores. These spores make up the brown stinking powder that fills the smutted grains.

GROWTH OF THE PARASITE.

The spores are really seeds in function, though extremely small and simple in structure. They serve to reproduce the fungus (smut) in the same sense as the grain reproduces the wheat plant. They adhere to the surface of the sound grains (especially when blown about during threshing), and when the wheat is planted germinate simultaneously with the latter. The delicate threads produced by germination penetrate the young wheat plant, and grow thereafter wholly concealed within. But when the head of the wheat plant appears, the young grains harbor a mass of fruiting threads which bear the spores at the end of short branches. The spores grow and the grain becomes gradually swollen until it considerably exceeds the healthy grain in size. As the spores ripen, they absorb the fruiting threads which bear them, till finally the smutted grain is filled with a mass consisting almost wholly of the ripe spores of the smut.

MICROSCOPIC CHARACTERS OF THE FUNGI CAUSING STINKING SMUT.

There are two, but very closely allied species of parasitic fungi which cause the stinking smut. Both develop in the same manner and both have the same peculiar odor. Sometimes only one occurs in smutted fields and sometimes both. Both kinds are found in Kansas and both were produced in our plots this year. The one species (apparently the commoner in the West) is known to botanists as *Tilletia fœtens* (B. & C.) Schroet.[1], and has rather regular sub-globose to elliptical spores which are *smooth walled* and 15-22x15-20μ[2] in diameter. The other species, known as *Tilletia Tritici* (Bjerkander) Winter[3] has regular globose spores which have a wall marked with *net-like ridges,* and are 16–20μ (mostly 17μ) in diameter.

GERMINATION OF THE SPORES.

The two species germinate in almost exactly the same manner, and hence a single account will serve for both species.

In water after four days or more the spores germinate, sending out a thick tube, the promycelium. If the spore be under water, this promycelium goes until it reaches the air. Then the tip produces a crown of long, slender, delicate bodies, the primary sporidia. These may be blown about by wind, but if not disturbed, become fused in pairs by means of a short tube growing from one to the other. Then the primary sporidia may produce slender tubes, capable of penetrating and infecting the wheat plant, but more often produce on short outgrowths the secondary sporidia, which are much shorter, thicker, curved, spindle-shaped bodies, which may themselves fuse. These secondary sporidia finally send forth slender threads,

[1]The principal synonomy of this species is as follows:

TILLETIA FŒTENS (Berkeley et Curtis) Schroeter.

1833. *Erysibe fœtida* Wallroth, Flora cryptog. Germ, pars post., p. 213, No. 1661. ?

1860. *Ustilago fœtens* Berkley et Curtis, in Ravenel, Fungi caroliniani exsiccati, Fasc. V., No. 100; Grevillea, Vol. III, No. 26, December 1874, Berkeley, Notices of North American Fungi, No. 573, p. 59. !

1873. *Tilletia lœvis* Kuhn, in Rabenhorst, Fungi europaei, Cent. XVI., No. 1697; Hedwigia 1874, S. 152. [1]

1877. *Tilletia fœtens* (Berkeley et Curtis) Schroeter, Bemerkungen and Beobachtungen uber einige Ustilagineen, in Cohn, Beitrage zur Biologie der Pflanzen, Band II, Heft. 3 (1877) S. 365.

[2] A μ is equal to about 1/25000 inch.

[3] The principal synonomy of this species is as follows:

TILLETIA TRITICI (Bjerkander) Winter.

1775. *Lycoperdon Tritici* Bjerkander, in Kgl. Vet. Akad. Handl., 1775, S. 326. (Cited from Rostrup.)

1815. *Uredo caries* De Candolle, Flora Frangaise, Vol VI, p. 78, No. 615b.

1816. *Uredo silophila* Ditmar, in Sturm, Deutschl. Flora, III Abth., Die Pilze Deutschlands, 3 Heft, S. 69, Tab. 34.

1847. *Tilletia Caries [DC.]* Tulasne, Mém, sur les Ustilaginées comp. aux Urédinées, in Ann.Sci.Nat., 3d série, tom. VII, p. 113, Tab. 5, figs. 1-16.

1877. *Tilletia silophila* (Ditmar) Schroeter, Bemerkungen and Beobachtungen über einige Ustilagineen, in Cohn, Beitrige zur Biologie der Pflanzen, Band II, Heft 3, (1877) S. 365.

1884. *Tilletia Tritici* (Bjerkander) Winter, Die Pilze, I Abth., S. 110, Nr. 145.

which enter the wheat plant and cause its infection, and are in fact the principal means by which the infection of the host plant is accomplished since the primary sporidia do not usually send out germ tubes at all.

The germination of *Tilletia Tritici* (Bjerk.) Wint. in nutrient solutions has been carefully studied by Brefeld, who finds the primary and secondary sporidia larger and more abundant than in water cultures. The primary sporidia produce, in a suitable nutrient solution, (such as a decoction of fresh stable manure,) a long branched mycelium which, after some days, as the nourishment becomes exhausted, produces on branches which grow into the air numerous secondary sporidia. These, under suitable conditions, produce germ tubes capable of infecting the host.

STINKING SMUTS AND LOOSE SMUT COMPARED.

The stinking smuts, which have been described in the foregoing pages, (see also Plate I and the explanation that precedes the plate,) should not be confused with the loose smut of wheat. The latter is caused by a third and quite different smut-fungus, namely, *Ustilago Tritici* (Persoon) Jensen. The loose smut is not confined to the grains (as the stinking smuts are), but attacks the whole head and converts it into a loose powdery mass of spores held together by a few shreds and plates of tissue. Moreover, the spores of the fungus causing the loose smut are very much smaller and germinate in an entirely different manner from those of the two Tilletias (stinking smuts). A full account of loose smut is given in the Second Annual Report of the Experiment Station, Kansas State Agricultural College, for 1889; Botanical Department, pp. 261-267, Pl. II and VI.

MODE OF INFECTION OF THE HOST PLANT.

The infection of the wheat plant is brought about, as mentioned before, by delicate tubes growing from the secondary or rarely from the primary sporidia of the smut, which penetrate the young tissues of the seedling. It is believed that these tubes can enter only the sheathing primary leaf or the collar between the root and stem, while they are yet very young and delicate.

From the above it may readily be inferred that anything which would hasten the development of the young plants would tend to lessen the chances of infection.

PREVENTION OF STINKING SMUT.

The object of all preventive treatments for this disease is to protect the young seedling from the chances of infection. It has been found that infection takes place almost wholly from the smut spores adhering to the grain when it is planted. Hence if these adhering smut spores can be killed without injuring the seed, the smut can be prevented.

Since the early part of this century, the almost universal method of preventing smut has been to soak the seed, before planting, in a solution of blue vitriol, (sulphate of copper.) Of the many forms of the treatment in use, perhaps the best is to immerse the seed twelve to fifteen hours in a one-half per cent. solution of copper sulphate, and then put the seed for five or ten-minutes in lime-water. This, if properly carried out, will prevent the smut, with the little injury to the crop. But the germinating power of the seed is somewhat lessened, and in many cases the young plants are weakened by this treatment.

The Jensen hot-water treatment, so successful in preventing oat smut, has proven equally efficacious against the stinking smut of wheat.[1] It appears at the same time to increase the yield of grain. We quote here an instructive series of experiments by J. L. Jensen,[2] carried out on four farms (four plots for each treatment on each farm) in different parts of Denmark. The six forms of treatment, as can be seen from the table below, were as follows:

One-half per cent. solution copper sulphate.
One per cent. solution copper sulphate.
Two per cent. solution copper sulphate.
Hot water, temperature 128° F.
Hot water, temperature 133° F.
Hot water, temperature 136° F.

The smut was entirely prevented in all the plots. Four untreated plots were planted in each series for comparison, and gave fifty-one per cent. of smutted grain.

Calling the yield 100 in case of the one-half per cent. copper solution ($CuSO_4$) treatment, (which was the best of the copper treatments,) the others were as follows:

	One-half per cent. copper sulphate.	*One per cent. copper sulphate.*	*Two per cent. copper sulphate.*	*Hot water, 128°.*	*Hot water, 133°.*	*Hot water, 136°*
First farm............	100	87	74	112	**128**	112
Second farm...........	100	86	67	126	**135**	124
Third farm............	100	84	52	111	**136**	119
Fourth farm...........	100	93	72	**139**	120	120
Averages....... ..	100	88	66	122	**128**	119

EXPERIMENTS IN PREVENTING SMUT.

Smutted seed wheat was obtained for experimental purposes late in the fall of 1889, through the kindness of Mr. S. I. Wilkin, of Bow Creek, Rooks county, Kansas. Examination showed that many grains were infected with stinking smut, both forms being present.

The land used for the experiments was that occupied in 1888 and 1889

[1] Very full experiments in preventing wheat smut are reported by Mr. J. L. Jensen, in his Danish paper, Om Kornsorternes Brand, (Anden Middelelse,) S. 7-31, og 39-53.
[2] Reported in Om Kornsorternes Brand, (Anden Middelelse,) S. 44.

by oat smut experiments, (see Bulletin No. 8 and Second An. Rep. Exp. Sta. Kans. State Agr. Coll.,) together with the land (adjoining the former on the east) occupied in 1889 by second year crossed corn, (see Second An. Rep. Kans. Exp. Sta.) The soil was a fairly good upland loam that had been under cultivation and manured (with stable manure) a few years before. On the land occupied by plots 1–6, stable manure had been again spread, in August, 1888.

The soil previously occupied by the oat-smut experiments had been plowed late in September, 1889, and was harrowed immediately before the wheat was planted. The soil was in very good condition, and on November 4, 1889, plots 1–29 were planted with a one-horse drill set at six pecks per acre, (except in case of plot 23, for which the machine was set at eight pecks.) The plots were between 31 and 35 feet long, and the drill was run out and back for each, making each plot six feet wide. The drill was cleaned thoroughly after planting each treated plot. After the treated plots were all planted, the alternate plots were planted with untreated seed.

The land for plots 31-103 (which had been previously in corn) was plowed November 5, 1889, and at once harrowed. On the same day plots 31-59 were planted in the same manner as numbers 1–29. The land was wet, but care was taken to secure as even seeding as possible. Plots 60-103 were not planted till November 23. For each of these the grain was dropped by hand in four furrows about ten feet long and eight and one-half inches apart. The furrows were then filled and the soil firmly pressed. As in case of the other plots, the treated seed was all put in the soil and covered before the untreated seed was planted.

Owing to the lateness of the planting, the seed germinated tardily and the plants very slowly. By January they were only one to two inches high. It is probably due largely to this slow growth that the amount of smut was so large. For it is in the highest degree probable that if the seedlings grow very slowly their tissues remain liable to infection a longer time.

The wheat of all the plots was protected by snow during much of the coldest weather, and consequently lived through the winter in good condition. The plants were, of course, small and backward in the spring, but grew fairly well. During the last week in June, 1890, the grain in plots 1–29 began to ripen, followed soon by that in the other plots.

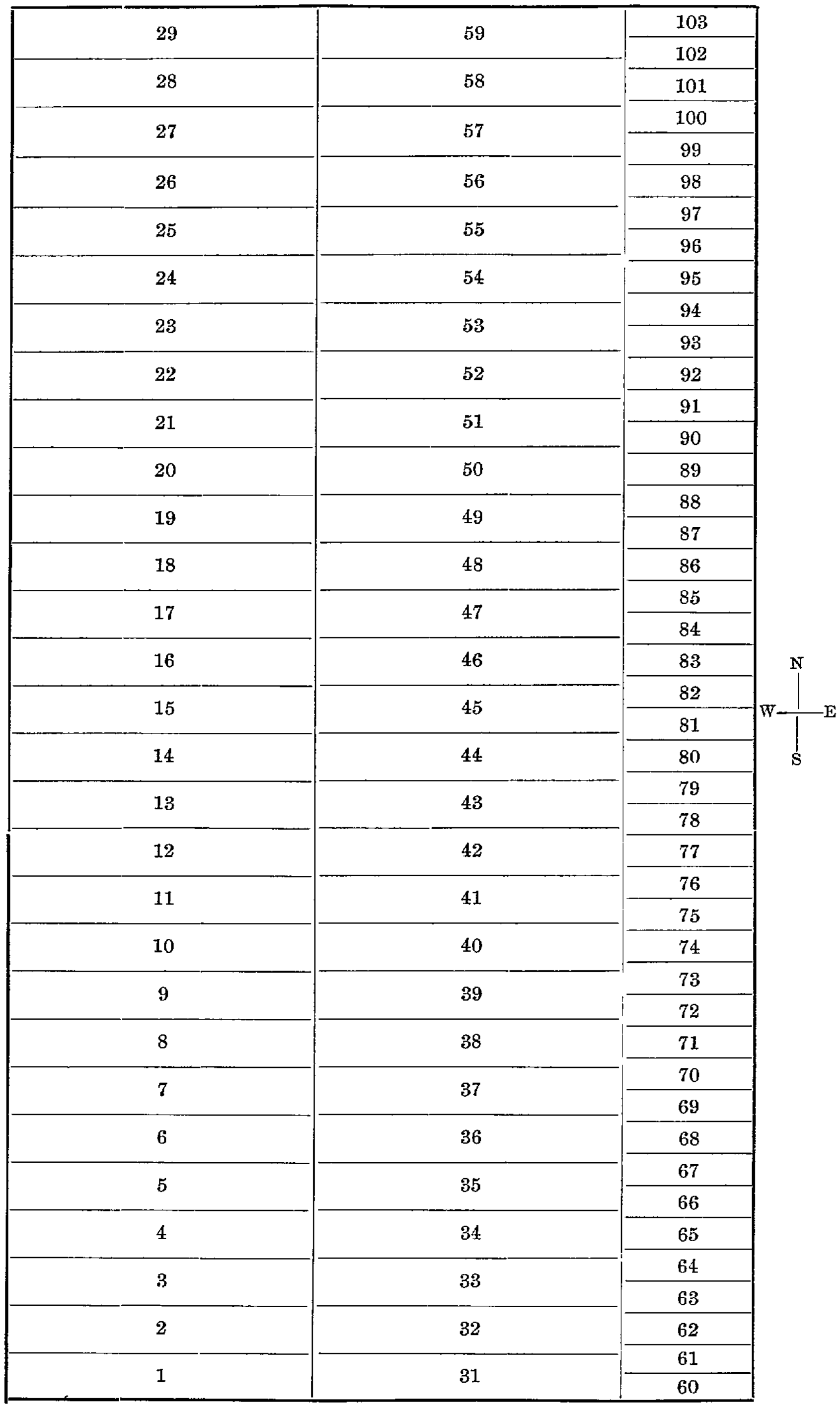
The very late planting and consequent backward condition of the crop may account for the very low yield even in the best of the treated plots.

Plots 29, 59, 60 and 103 were somewhat stunted by trees growing near by.

ARRANGEMENT OF PLOTS AND TABULATION OF RESULTS.

The table on following page shows the relative sizes and positions of the plots (the unoccupied spaces between the plots being omitted from the diagram). It is followed by tables showing the treatments and the results.

DIAGRAM SHOWING PLOTS IN WHEAT-SMUT EXPERIMENT, 1889-1890.



TABULATION

No.	TREATMENT.	Size of plot in square feet.	ACTUAL YIELD				
			Total heads.	Smutted heads.	Per cent. smutted.	Sound grain.	
						Lbs.	Oz.
1	Lye, 3½ oz. to 2 qts. water, 24 hours*	210	0	0	....	....	
2	Untreated	210	3652	2092	57.28	....	
3	Lye, 3½ oz. to 2 qts. water, 15 minutes	210	0	0	....	....	
4	Untreated	210	3417	2148	62.86	....	
5	Lye, 3½ oz. to 4 qts. water, 24 hours	210	0	0	....	....	
6	Untreated	210	3130	1676	53.54	1	12
7	Lye, 3½ oz. to 4 qts. water, 15 minutes	207	2049	7	.34	2	6½
8	Untreated	207	3183	1960	61.57	1	4¼
9	Hot water, 139–140° F., 15 min.; smutted grains skimmed off	207	9	0	0		¼
10	Untreated	207	3642	2427	66.63	1	5½
11	Hot water, 140–141° F., 15 min.; smutted grains not skimmed off	207	711	0	0		10
12	Untreated	207	3795	2464	64.4	1	8
13	Hot water, 131–132° F., 15 min.; smutted grains skimmed off	204	3912	5	.13	4	⅝
14	Untreated	207	4087	2578	63.07	1	10
15	Hot water, 132–131° F., 15 min.; smutted grains not skimmed off	210	4012	33	.82	4	7⅛
16	Untreated	207	4671	2990	64.	....	
17	Hot water, 118½–120° F., 15 min.; smutted grains not skimmed off	207	4533	2622	57.84	....	
18	Untreated	207	4786	3539	73.94	....	
19	Hot water, 118½–120° F., 15 min.; smutted grains skimmed off	207	4617	2029	43.94	....	
20	Untreated	207	4003	2491	62.22	....	
21	Copper sulphate, 8 per cent., 24 hours, not limed	207	3055	11	.36	....	
22	Untreated	207	3782	2422	64.04	....	
23	Copper sulphate, 8 per cent., 24 hours, limed	201	2879	9	.31	3	7½
24	Untreated	201	3440	2257	65.61	1	7
25	Copper sulphate, 5 per cent., 24 hours, not limed	201	2991	0	0	3	12
26	Untreated	198	4103	2806	68.38	1	6½
27	Bordeaux mixture, (copper sulphate 2⅔ lbs., lime 5 lbs., water 4 gals.,) 36 hours,	198	2820	0	0	....	
28	Untreated	198	3864	2508	72.15	....	
29	Bordeaux mixture, half strength, 36 hours,	220.5	5893	4	.06	....	
31	Eau celeste, (1 lb. copper sulphate, 1½ pts. ammonium hydrate, 22 gals. water,) 24 hours	181.5	0	0	....	....	
32	Untreated	181.5	4085	2550	62.42	1	14
33	Sodium hyposulphite, 10 per cent., 24 hours,	181.5	2889	1379	47.73	1	13½

*Unfortunately, the weights of the grain and straw of plots 1-5, 16-22, 27-29, and 55-59 were not

OF RESULTS.

PER PLOT.							CALCULATED YIELD PER ACRE.				
Smutted grain.	*Straw of sound heads.*		*Straw of smutted heads.*		*Total straw.*		*Sound grain.*	*Smutted grain.*	*Straw of sound heads.*	*Straw of smutted heads.*	*Total straw.*
Oz.	*Lbs.*	*Oz.*	*Lbs.*	*Oz.*	*Lbs.*	*Oz.*	*Bu.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
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$7\frac{1}{8}$	2	$8\frac{1}{2}$	2	$1\frac{7}{8}$	4	$10\frac{3}{8}$	6.05	92.37	525.05	434.70	959.75
$\frac{1}{32}$	3	$10\frac{1}{8}$		$\frac{3}{32}$	3	$10\frac{7}{32}$	8.43	.41	764.47	1.23	765.70
$8\frac{1}{8}$	2	$2\frac{1}{8}$	2	$5\frac{3}{8}$	4	$7\frac{1}{2}$	4.43	106.86	448.81	491.56	940.37
0		$\frac{1}{4}$	0			$\frac{1}{4}$	.054	0	.304	0	.304
$10\frac{1}{2}$	1	15	2	$15\frac{1}{2}$	4	$14\frac{1}{2}$	4.71	138.09	407.71	624.72	1032.43
0	1	3	0		1	3	2.19	0	249.89	0	249.89
$12\frac{1}{8}$	2	3	2	$12\frac{7}{8}$	4	$15\frac{7}{8}$	5.25	153.49	814.42	590.2	1404.62
$\frac{1}{32}$	6	$8\frac{1}{4}$		$\frac{3}{32}$	6	$8\frac{11}{32}$	14.37	.41	1391.27	1.23	1392.5
$12\frac{7}{8}$	2	$9\frac{7}{8}$	3	$\frac{5}{8}$	5	$10\frac{1}{2}$	5.7	169.36	550.72	639.52	1190.24
$\frac{3}{16}$	6	$15\frac{7}{8}$		$\frac{9}{16}$	7	$\frac{7}{16}$	15.36	2.43	1450.37	7.29	1457.66
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$\frac{1}{32}$	5	12		$\frac{3}{32}$	5	$12\frac{3}{32}$	12.52	.42	1246.11	1.26	1247.37
$9\frac{7}{8}$	2	5	3	$2\frac{1}{8}$	5	$7\frac{1}{8}$	5.19	133.24	501.15	678.93	1180.08
0	6	$1\frac{5}{8}$	0		6	$1\frac{5}{8}$	13.54	0	1322.3	0	1322.3
$6\frac{1}{4}$	2	$3\frac{1}{4}$	3	$11\frac{3}{4}$	5	15	5.15	85.93	484.68	821.56	1306.24
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$12\frac{3}{4}$	2	11	3	$\frac{3}{4}$	5	$11\frac{3}{4}$	7.5	191.25	645.	731.25	1376.25
$5\frac{1}{8}$	3	$2\frac{1}{4}$	2	$1\frac{3}{8}$	5	$3\frac{7}{8}$	7.37	76.87	753.75	500.62	1254.37

preserved.

TABULATION OF

No.	TREATMENT.	Size of plot in square feet.	ACTUAL YIELD				
			Total heads.	Smutted heads.	Per cent. smutted.	Sound grain.	
						Lbs.	Oz.
34	Untreated	181.5	3987	2637	66.13	1	4¾
35	Sodium hyposulphite, 10 per cent., 24 hours, limed	181.5	2291	98	4.27	2	8⅜
36	Untreated	181.5	4162	2568	61.7	1	11
37	Sodium hyposulphite, 5 per cent., 24 hours,	181.5	3437	1932	56.21	1	10½
38	Untreated	181.5	4016	2832	70.51	1	1⅝
39	Potassium sulphide, 2 oz. to 3 gals., 24 hours,	181.5	4100	2690	65.6	1	3¾
40	Untreated	181.5	3121	2238	71.7		12½
41	Potassium sulphide, 2 oz. to 6 gals., 24 hours,	181.5	3350	2361	70.47	1	¾
42	Untreated	181.5	3851	2510	65.17	1	9
43	Potassium sulphide, 2 oz. to 6 gals., 24 hours, limed	181.5	3259	377	11.56	3	3½
44	Untreated	181.5	3453	2389	66.29	1	3½
45	Arsenic, saturated aqueous solution, 24 hrs.,	181.5	2728	30	1.09	3	7
46	Untreated	181.5	3727	2830	75.9	1	4¾
47	Arsenic and lime, mixt. of saturated sol. of each in equal proportion, 24 hours	181.5	3116	516	16.55	2	12
48	Untreated	181.5	4331	3090	71.34	1	7½
49	Lime, saturated solution, 24 hours	192	3050	152	4.98	3	1½
50	Untreated	192	4304	2938	68.26	1	7
51	Salt, saturated solution, 36 hours	192	2620	989	37.74	1	15⅝
52	Untreated	192	3917	2519	64.3	1	5⅞
53	Salt, saturated solution, diluted one-half, 36 hours	189	2751	579	21.04		14½
54	Untreated	189	2781	2286	82.2	1	1
55	Castile soap, saturated solution in water, 36 hours	189	2414	1556	64.45	......	
56	Untreated	189	3843	2769	72.05	......	
57	Copper sulphate, ½ per cent. solution, 24 hours	189	2293	17	.74	......	
58	Untreated	189	3043	2280	74.92	......	
59	Soaked in cistern water 24 hours	186	2507	1882	75.06	......	
60	Untreated	30	615	463	75.26		1⅝
61	Chloroform vapor, 24 hours	30	850	666	78.35		3¼
62	Untreated	30	872	655	75.11		3⅜
63	Chloroform, grain moistened with chloroform and left in vapor 48 hours	30	307	176	57.32		1⅞
64	Untreated	30	987	697	70.61		3⅜
65	Sulphurous oxide (SO_2) gas, 48 hours	30	327	35	10.7		5¼
66	Untreated	30	864	656	76.92		3⅞
67	Carbon bisulphide (CS_2) vapor, 48 hours	30	490	232	47.34		4¼
68	Untreated	30	813	614	75.52		2⅞

RESULT - CONTINUED.

PER PLOT.							CALCULATED YIELD PER ACRE.				
Smutted grain.	Straw of sound heads.		Straw of smutted heads.		Total straw.		Sound grain.	Smutted grain.	Straw of sound heads.	Straw of smutted heads.	Total straw.
Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Bu.	Lbs.	Lbs.	Lbs.	Lbs.
$9\frac{1}{2}$	2	5	2	12	5	1	5.18	142.5	555.	660.	1215.
$\frac{1}{2}$	3	$2\frac{1}{4}$		$2\frac{1}{2}$	3	$5\frac{1}{4}$	10.09	7.5	761.25	37.5	798.75
$9\frac{5}{8}$	2	12	2	$14\frac{3}{8}$	5	$10\frac{3}{8}$	6.75	144.37	660.	695.62	1355.62
$9\frac{1}{8}$	2	$10\frac{3}{4}$	2	$4\frac{7}{8}$	4	$15\frac{5}{8}$	6.62	136.87	641.25	553.12	1194.37
$9\frac{5}{8}$	1	$13\frac{1}{8}$	2	$14\frac{7}{8}$	4	12	4.4	144.37	436.87	703.12	1140.
$7\frac{5}{8}$	2	$2\frac{3}{4}$	2	$12\frac{3}{8}$	4	$15\frac{1}{8}$	4.93	114.37	521.25	665.62	1186.87
$5\frac{1}{2}$	1	$3\frac{1}{2}$	2	$4\frac{1}{2}$	3	8	3.12	82.5	292.5	547.5	840.
$9\frac{1}{2}$	1	$10\frac{1}{4}$	2	$13\frac{1}{2}$	4	$7\frac{3}{4}$	4.18	142.5	393.76	682.5	1076.25
10	2	4	2	$15\frac{1}{2}$	5	$3\frac{1}{2}$	6.25	150.	510.	712.5	1252.5
$1\frac{1}{8}$	5	1		$6\frac{7}{8}$	5	$7\frac{7}{8}$	13.12	16.87	1215.	103.12	1318.12
7	1	$15\frac{1}{8}$	2	$15\frac{1}{2}$	4	$14\frac{3}{8}$	4.87	105.	468.87	712.5	1181.37
$\frac{1}{4}$	5	$14\frac{1}{4}$		1	5	$15\frac{1}{4}$	13.75	3.75	1417.5	15.	1432.5
$9\frac{1}{8}$	2	$4\frac{1}{4}$	3	$10\frac{3}{8}$	5	$14\frac{5}{8}$	5.18	136.87	543.75	875.62	1419.37
$1\frac{5}{8}$	4	$11\frac{1}{8}$		$9\frac{3}{8}$	5	$4\frac{1}{2}$	11.	24.37	1126.87	140.62	1267.5
$12\frac{3}{4}$	2	4	3	$12\frac{3}{4}$	6	$\frac{3}{4}$	5.87	191.25	540.	911.25	1451.25
$\frac{1}{2}$	5	$14\frac{7}{8}$		$3\frac{1}{2}$	6	$2\frac{3}{8}$	11.69	7.09	1345.29	49.62	1391.91
10	2	$4\frac{1}{2}$	3	$11\frac{1}{2}$	6		5.43	141.79	517.55	843.69	1361.24
$3\frac{1}{2}$	3	$2\frac{5}{8}$	1	7	4	$9\frac{5}{8}$	7.47	49.62	717.84	325.35	1043.19
$8\frac{1}{2}$	2	$3\frac{1}{4}$	3	$6\frac{1}{2}$	5	$9\frac{3}{4}$	5.16	120.52	499.83	772.79	1272.62
$1\frac{7}{8}$	4	$6\frac{1}{2}$		$15\frac{1}{8}$	5	$5\frac{5}{8}$	11.16	27.	1412.91	217.87	1630.78
$6\frac{3}{8}$	1	$7\frac{1}{2}$	2	$4\frac{1}{8}$	3	$11\frac{5}{8}$	4.08	91.83	338.51	520.37	858.88
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
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.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$\frac{7}{8}$		$3\frac{3}{4}$		$9\frac{1}{8}$		$12\frac{7}{8}$	2.08	79.4	341.31	828.09	1169.4
$2\frac{1}{2}$		$4\frac{1}{2}$	1	15	2	$3\frac{1}{2}$	4.91	234.37	408.37	2813.25	3221.62
$2\frac{1}{2}$		$7\frac{1}{8}$		14	1	$5\frac{1}{8}$	5.1	234.37	646.59	1270.5	1917.09
$\frac{5}{8}$		$4\frac{3}{4}$		$4\frac{3}{8}$		$9\frac{1}{8}$	2.83	56.71	431.06	397.03	828.09
2		$7\frac{3}{4}$		12	1	$3\frac{3}{4}$	5.1	181.5	703.31	1089.	1792.31
$\frac{5}{24}$		$10\frac{1}{2}$		$\frac{11}{12}$		$11\frac{5}{12}$	7.94	18.9	952.87	83.18	1036.05
$2\frac{1}{2}$		$6\frac{1}{8}$		$12\frac{1}{2}$	1	$2\frac{5}{8}$	5.86	226.87	555.84	1134.37	1690.21
$1\frac{9}{16}$		$8\frac{7}{8}$		$5\frac{7}{16}$		$14\frac{5}{16}$	6.42	141.79	805.4	493.45	1298.95
$1\frac{7}{8}$		$5\frac{5}{8}$		$11\frac{1}{8}$	1	$\frac{3}{4}$	4.34	170.15	510.46	1009.59	1520.05

TABULATION OF

No.	TREATMENT.	Size of plot in square feet.	ACTUAL YIELD			
			Total heads.	Smutted heads.	Per cent. smutted.	Sound grain.
						Oz.
69	Ether, vapor, 48 hours	30	649	500	77.04	$2\frac{5}{8}$
70	Untreated	30	1004	639	63.64	$3\frac{1}{4}$
71	Ammonium hydrate vapor, 24 hours	30	141	48	34.04	$1\frac{1}{2}$
72	Untreated	30	768	604	76.64	$2\frac{5}{8}$
73	Ammonium hydrate, 5 per cent. solution, 20 hours	30	18	2	11.11	$\frac{1}{8}$
74	Untreated	30	737	581	78.83	$2\frac{1}{4}$
75	Ammonium hydrate, 10 per cent. solution, 20 hours	30	0	0	....	.....
76	Untreated	30	839	620	73.89	4
77	Carbolic acid, 5 per cent. solution, 20 hours,	30	0	0	....	.....
78	Untreated	30	828	660	79.71	$2\frac{1}{2}$
79	Carbolic acid 10 per cent. solution, 20 hours,	30	0	0	....	.....
80	Untreated	30	745	627	84.16	$1\frac{3}{8}$
81	Sodium bicarbonate ($NaHCo_3$), 5 per cent. solution, 20 hours	30	450	298	66.22	$3\frac{1}{2}$
82	Untreated	30	848	625	77.35	$3\frac{1}{2}$
83	Sodium bicarbonate ($NaHCo_3$), 10 per cent. solution, 20 hours	30	557	297	53.32	$6\frac{1}{8}$
84	Untreated	30	877	730	83.24	$2\frac{5}{8}$
85	Sodium carbonate, "sal soda" (Na_2Co_3), 5 per cent. solution, 20 hours.	30	588	279	47.44	$7\frac{3}{8}$
86	Untreated	30	1004	584	58.16	4
87	Potassium bichromate, 5 per cent. solution, 20 hours	30	464	0	0	$11\frac{1}{4}$
88	Untreated	30	884	676	76.47	$3\frac{3}{8}$
89	Mercuric chloride, "corrosive sublimate," ($HgCl_2$), $.6\frac{2}{3}$ per cent. sol., 20 hours	30	9	0	0	$\frac{1}{8}$
90	Untreated	30	899	692	76.97	$3\frac{7}{8}$
91	Mercuric chloride, "corrosive sublimate," ($HgCl_2$), 1 per cent. sol., 20 hours	30	0	0	....	.....
92	Untreated	30	674	550	81.6	$2\frac{1}{2}$
93	Salicylic acid, concentrated solution, 20 hours	30	54	0	0	$\frac{1}{8}$
94	Untreated	30	917	693	75.57	$3\frac{3}{4}$
95	Salicylic acid, concentrated solution, $2\frac{1}{2}$ hours	30	757	265	35.	8
96	Untreated	30	834	714	85.61	$1\frac{3}{4}$
97	Sodium sulphate, 5 per cent. solution, 20 hours	30	479	362	75.57	2
98	Untreated	30	874	713	81.57	$2\frac{1}{8}$
99	Sodium sulphate, 10 per cent. solution, 20 hours	30	434	322	74.19	$2\frac{1}{8}$
100	Untreated	30	721	616	85.43	$1\frac{3}{8}$
101	1 part conc. alcoholic sol. salicylic acid diluted with 9 parts water, 20 hours	30	0	0	....	.....
102	Untreated	30	641	536	83.61	$\frac{7}{8}$
103	1 part conc. alcoholic sol. salicylic acid diluted with 9 parts water, $2\frac{1}{2}$ hours	30	510	302	59.21	$1\frac{7}{8}$

RESULTS - CONTINUED.

PER PLOT.						CALCULATED YIELD PER ACRE.				
Smutted grain.	*Straw of sound heads.*		*Straw of smutted heads.*	*Total straw.*		*Sound grain.*	*Smutted grain.*	*Straw of sound heads.*	*Straw of smutted heads.*	*Total straw.*
Oz.	*Lbs.*	*Oz.*	*Oz.*	*Lbs.*	*Oz.*	*Bu.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
$2\frac{1}{2}$		$4\frac{7}{8}$	$10\frac{1}{2}$		$15\frac{3}{8}$	3.97	226.87	442.4	952.87	1395.27
$3\frac{3}{8}$		$6\frac{7}{8}$	$8\frac{1}{8}$		15	4.91	306.28	623.9	737.34	1361.24
$\frac{1}{8}$		3	$1\frac{1}{2}$		$4\frac{1}{2}$	2.26	11.34	272.25	136.12	408.37
$2\frac{1}{8}$		$5\frac{3}{8}$	$12\frac{3}{8}$	1	$1\frac{3}{4}$	3.95	192.78	487.78	1123.03	1610.81
$\frac{1}{64}$		$\frac{1}{2}$	$\frac{3}{64}$		$\frac{35}{64}$	.189	1.41	45.37	4.25	49.62
2		$4\frac{7}{8}$	11		$15\frac{7}{8}$	3.4	181.5	442.4	998.25	1440.65
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$2\frac{3}{4}$		$5\frac{3}{8}$	$11\frac{3}{4}$	1	$1\frac{1}{8}$	6.05	249.56	487.78	1066.31	1554.09
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$2\frac{1}{4}$		$4\frac{5}{8}$	$11\frac{3}{4}$	1	$\frac{3}{8}$	3.78	204.18	419.71	1066.31	1486.02
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2		$4\frac{3}{4}$	12	1	$\frac{3}{4}$	2.02	181.5	431.06	1089.	1520.06
$1\frac{1}{8}$		7	$7\frac{7}{8}$		$14\frac{7}{8}$	5.29	102.09	635.25	714.65	1349.9
$2\frac{1}{2}$		$5\frac{1}{2}$	13	1	$2\frac{1}{2}$	5.29	226.87	499.12	1179.75	1678.87
$1\frac{3}{8}$		$10\frac{1}{8}$	$7\frac{5}{8}$	1	$1\frac{3}{4}$	9.26	124.78	918.84	691.96	1610.8
$3\frac{1}{4}$		$4\frac{7}{8}$	$15\frac{1}{4}$	1	$4\frac{1}{8}$	3.97	294.93	442.4	1383.92	1826.32
$1\frac{1}{2}$		$12\frac{3}{8}$	$7\frac{1}{2}$	1	$3\frac{7}{8}$	11.15	136.12	1123.03	680.62	1803.23
$3\frac{3}{8}$		$6\frac{1}{2}$	$12\frac{7}{8}$	1	$3\frac{3}{8}$	6.05	306.28	589.87	1168.4	1758.27
0	1	1	0	1	1	17.01	0	1542.75	0	1542.75
$2\frac{7}{8}$		6	12	1	$2\frac{1}{8}$	5.1	260.9	544.5	1134.37	1678.87
0		$\frac{3}{8}$	0		$\frac{3}{8}$	.18	0	34.3	0	34.3
$2\frac{3}{8}$		$6\frac{1}{4}$	$12\frac{5}{8}$	1	$2\frac{7}{8}$	5.86	215.53	567.18	1145.71	1712.89
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2		$3\frac{7}{8}$	9		$12\frac{7}{8}$	3.78	181.5	351.65	816.75	1168.4
0		$1\frac{5}{8}$	0		$1\frac{5}{8}$	.18	0	147.46	0	147.46
$2\frac{3}{8}$		$6\frac{1}{2}$	$12\frac{1}{8}$	1	$2\frac{5}{8}$	5.67	215.53	589.87	1100.34	1690.21
1		$13\frac{1}{8}$	$5\frac{1}{4}$	1	$2\frac{3}{8}$	12.1	90.75	1027.03	476.43	1503.46
$3\frac{1}{8}$		$2\frac{5}{8}$	$10\frac{3}{8}$		13	2.64	283.59	238.21	941.53	1179.74
$\frac{1}{2}$		$3\frac{1}{8}$	$7\frac{1}{2}$		$10\frac{5}{8}$	3.02	131.12	283.59	680.62	964.21
$2\frac{3}{8}$		$3\frac{5}{8}$	$9\frac{1}{8}$		$12\frac{3}{4}$	3.21	215.53	328.96	828.09	1157.05
$1\frac{1}{4}$		$3\frac{1}{4}$	$5\frac{3}{4}$		9	3.21	113.43	294.93	487.78	682.71
$1\frac{3}{4}$		$1\frac{3}{4}$	$6\frac{1}{4}$		8	2.01	158.81	158.81	567.18	725.99
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
$\frac{7}{8}$		1	$5\frac{3}{8}$		$6\frac{3}{8}$	1.32	79.4	90.75	487.78	578.53
$\frac{5}{8}$		$2\frac{3}{8}$	2		$4\frac{3}{8}$	2.83	56.71	215.53	181.05	396.58

NOTES ON THE TREATMENTS.

The grain in all cases, when treated with solutions, was first thrown into the liquid, and, after being wetted, the smutted and imperfect seeds which floated were skimmed off. The grain was left in the solution the specified time, in most cases being well shaken at several different times, and then spread out to dry in an unoccupied room. In most cases, nearly two quarts of the solution were used for the required seed.

When treated with vapors the grain was placed on a piece of wire netting supported on a tripod, under which was placed the vessel of liquid yielding the vapor. Over the whole a large bell-jar was placed.

The numbers marked "limed" were rolled in powdered air-slaked lime after being taken out of the solution and allowed to drain.

REMARKS ON THE MORE IMPORTANT RESULTS SHOWN IN THE PRECEDING TABLE.

Of the 51 different treatments used in the experiments, three, viz.:

No. 25, Copper sulphate 5 per cent. sol., 24 hours,
No. 27, Bordeaux mixture, 36 hours,
No. 87, Potassium bichromate 5 per cent. sol., 20 hours,

prevented all the smut, though all injured the stand of the wheat somewhat. However, in spite of this injury they increased the yield to two or three times that of untreated plots.

Besides the above favorable treatments, six others, viz.:

No. 13, Hot water 131–132° F., 15 minutes, skimmed,
No. 15, Hot water 132–131° F., 15 minutes,
No. 21, Copper sulphate 8 per cent. sol., 24 hours,
No. 23, Copper sulphate 8 per cent. sol., 24 hours, limed,
No. 29, Bordeaux mixture half-strength, 36 hours,
No. 57, Copper sulphate ½ per cent. sol., 24 hours,

gave less than one per cent. smutted heads, and from two to three times the amount of grain obtained from untreated plots.

Plot 45, treated with a saturated solution of arsenic 24 hours, gave only 1.09 per cent. of smutted heads and a yield more than two and one-half times that of the adjacent untreated plots.

The following treatments:

No. 35, Sodium hyposulphite, 10 per cent. sol. 24 hours, limed,
No. 43, Potassium sulphide, 2 oz. to 6 gals. water, 24 hours, limed,
No. 47, Arsenic and lime, mixture of equal parts sat. sol. of each, 24 hours,
No. 53, Salt, saturated solution diluted one-half, 36 hours,

gave per cent. of smut varying from 4.27 (in No. 35) to 21.04 (in No. 53). The yield exceeded that of the adjacent untreated plots two to two and one-half times. The per cent. of smut, though only a small fraction of that in untreated plots, reduces the value of the treatments.

The following treatments, viz.:

No. 1, Lye 3½ oz. to 2 qts. water, 24 hours,
No. 3, Lye 3½ oz. to 2 qts. water, 15 minutes,
No. 5, Lye 3½ oz. to 4 qts. water, 24 hours,
No. 31, Eau celeste, 36 hours,
No. 75, Ammonium hydrate, 10 per cent. sol., 20 hours,
No. 77, Carbolic acid, 5 per cent. sol., 20 hours,
No. 79, Carbolic acid 10 per cent. sol., 20 hours,
No. 91, Corrosive sublimate, 1 per cent, sol., 20 hours,
No. 101, One part alcoholic sol. salicylic acid to 9 parts water, 20 hours,

destroyed all the grain, while the following treatments, viz.,

No. 9, Hot water, 139–140° F., 15 minute, skimmed,
No. 11, Hot water, 140–141° F., 15 minutes,
No. 73, Ammonium hydrate, 5 per cent. sol., 20 hours,
No. 89, Mercuric chloride, .632/3 per cent. sol., 20 hours,

destroyed at least four-fifths of the grain.

All the other treatments decreased the smut only slightly, and consequently increased the yield but little.

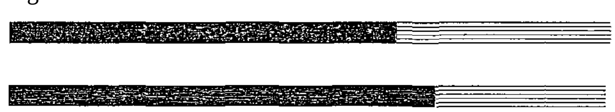
It should be noted that plot twenty-nine was planted with one-half more seed than usual, the drill being run through the plot three times, instead of twice, as in the other plats, (from 1–59.) The number of stalks in this plot is hence abnormally high. Also in plot eighty-six the number is too high, perhaps from an accident in seeding.

It is an interesting fact that the per cent. of smut is greater in the plots planted latest. This is, perhaps, because the young wheat plants in the latest planting grew more slowly than in the first planting, and hence were exposed to greater chances of infection. The untreated plots in the first planting (Nov. 4, plots 1–29,) are 14 in number, and average 64.26 per cent. smutted, while the 22 untreated plots in the last planting (Nov. 23, plots 60–103,) average 77.09 per cent. smutted.

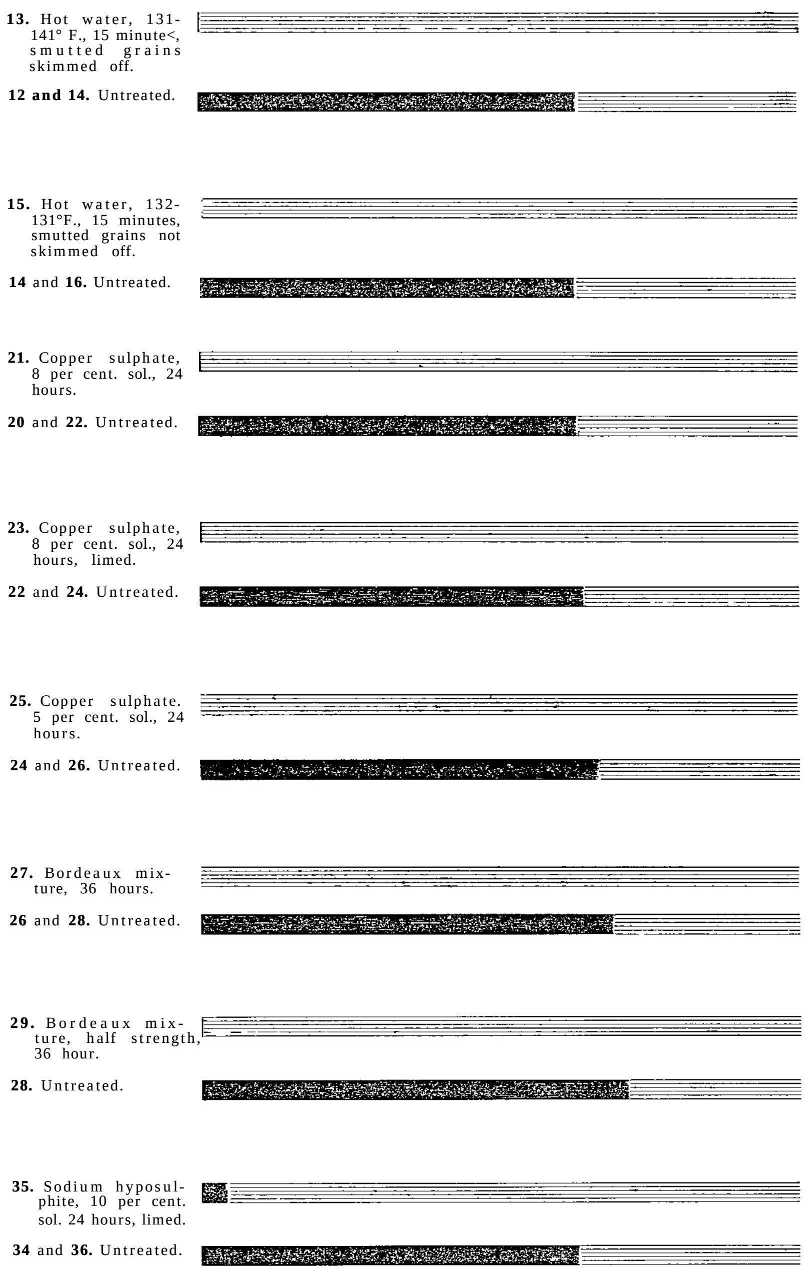
This is shown graphically in the following diagram, the black portion of the block indicating the amount of smut:

Nos. 2—28 Average per cent. of smut in untreated plots.

60—102. Average per cent. of smut in untreated plots.

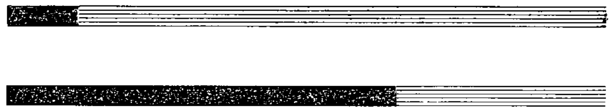


The following graphic representation shows the per cent. of smut in the fifteen most successful treatments, the percentage in each being compared with the average of the two adjacent untreated plots:



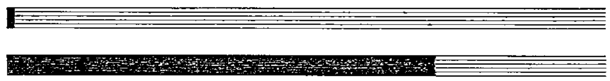
43. Potassium sulphide, 2 oz. to 6 gallons, 24 hours, limed.

42 and **44.** Untreated.



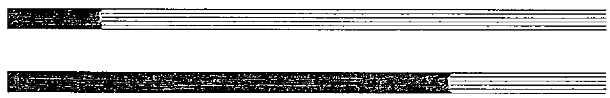
45. Arsenic, sat. sol., 24 hours.

44 and **46.** Untreated.



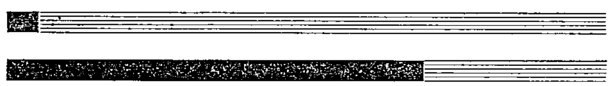
47. Arsenic and lime, mixture of sat. sol. of each, 24 hours,

46 and **48.** Untreated.



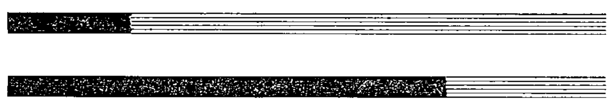
49. Lime, sat. sol., 24 hours.

48 and **50.** Untreated.



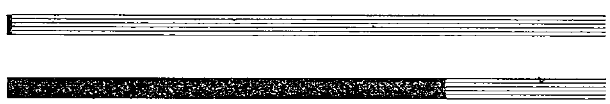
53. Salt, sat. sol., diluted one-half, 36 hours.

52 and **54.** Untreated.



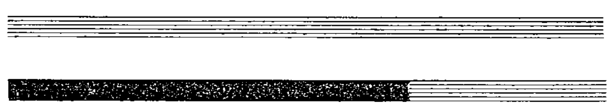
57. Copper sulphate, ½ per cent. sol., 24 hours.

56 and **58.** Untreated.

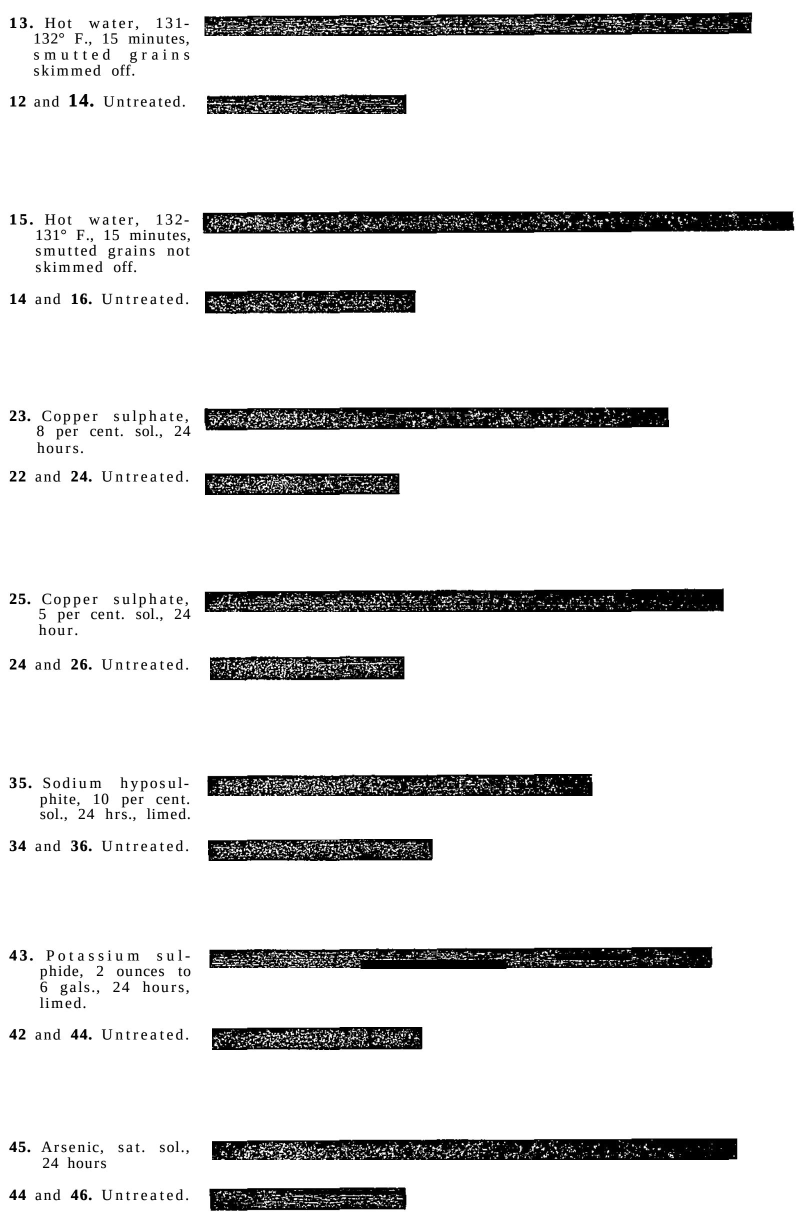


87. Potassium bichromate, 6 per cent. sol., 20 hours.

86 and 88. Untreated.

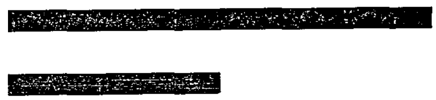


The following graphic representation shows the yields of eleven of the most successful treatments, compared in each case with the average yield of the two adjacent untreated plots. Each one-fifth of an inch in length represents a yield of one bushel per acre:



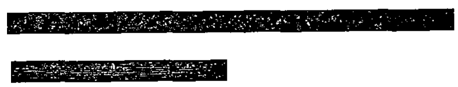
47. Arsenic and lime, mixture of sat. sol. of each, 24 hours.

46. and **48.** Untreated.



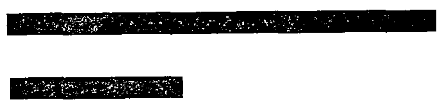
49. Lime, sat. sol., 24 hours.

48 and **49.** Untreated.



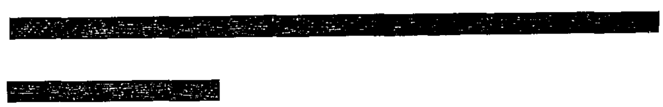
53. Salt, sat. sol., diluted one-half, 36 hours.

52 and **54.** Untreated.

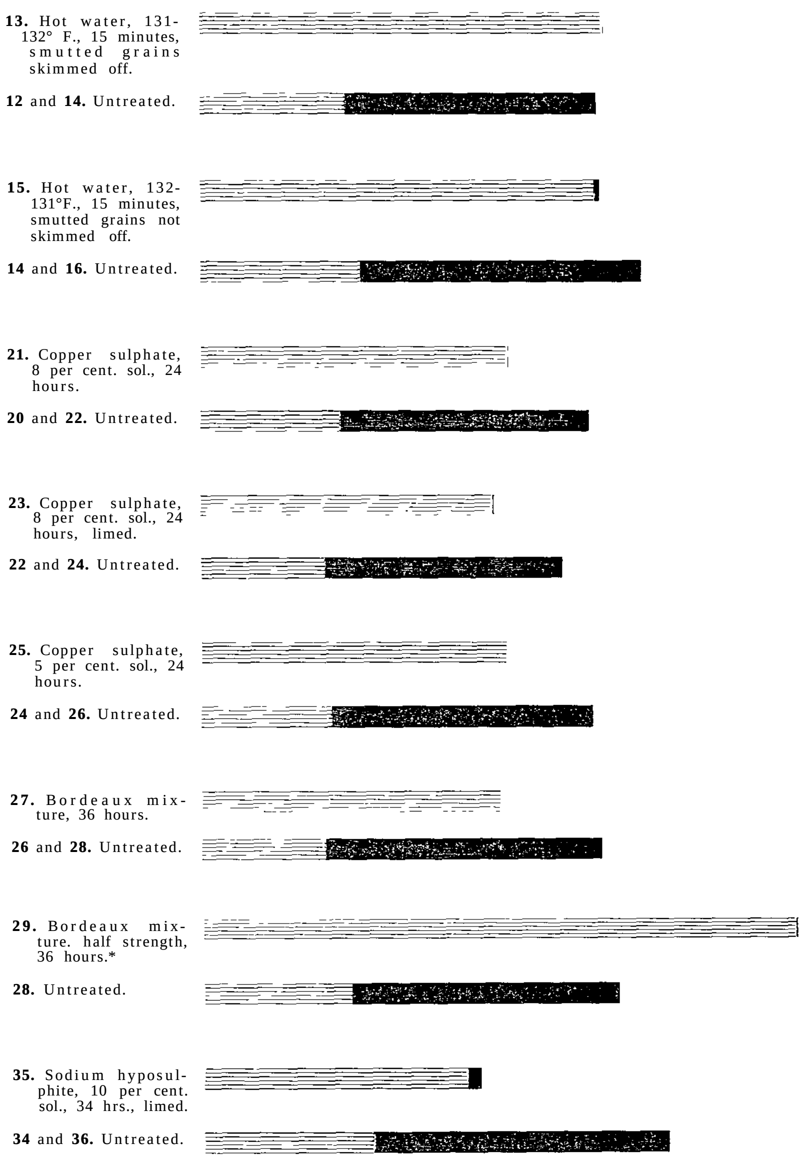


87. Potassium bichromate, 5 per cent. sol., 20 hours.

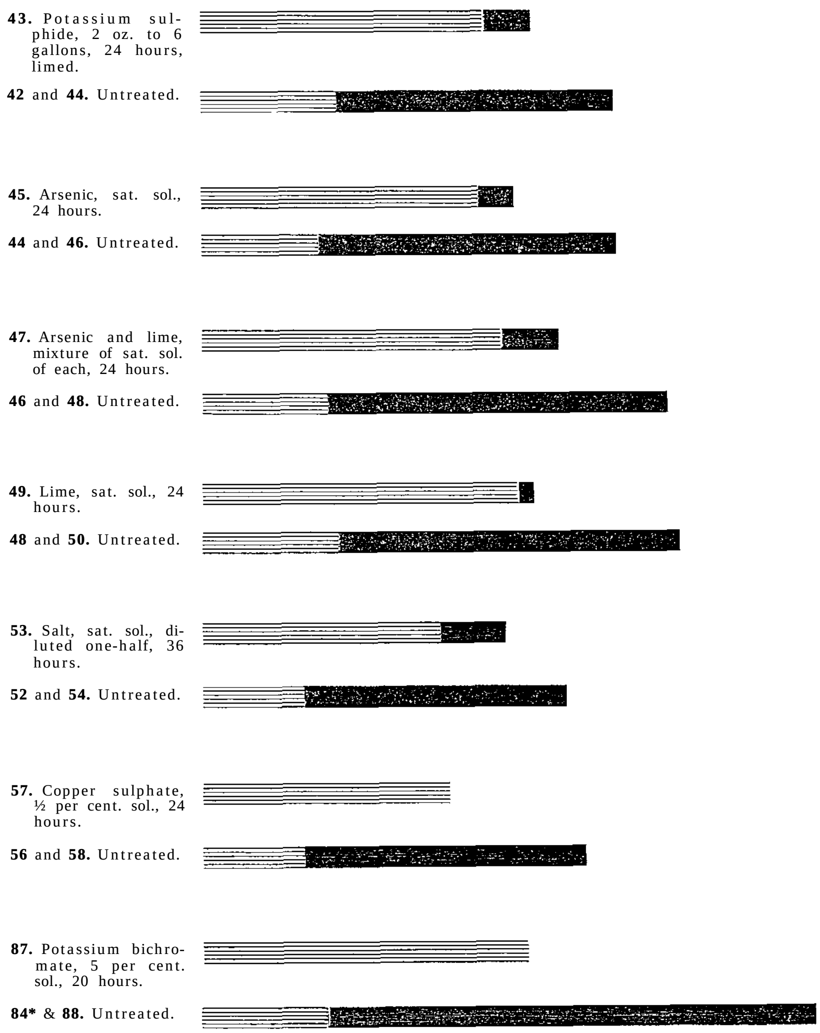
86 and **88.** Untreated.



The following graphic representation shows the stand in the fifteen best treatments compared in each case with that of the average of two adjacent untreated plats. The total length represents the total number of heads produced, (one-eighth inch in length representing 50,000 heads per acre,) while the blackened end shows the number destroyed by smut:



* This plot received one-half more seed than the others, and hence the stand is abnormally high.



Of all the treatments tested, the Jensen, or hot-water method, is probably the best for general use, although, in our experiments, it did not prevent all the smut. However, in the most favorable form, that used in plot 13, only 5 heads out of 3912 were smutted, and it is probable that these were accidental, since they grew from two hills on the edges of the plot.

The Jensen treatment was the only one which gave a full stand and yet destroyed the smut. Moreover, this treatment gave the highest yield of any, excepting plot 87, and this plot was so small that the results are probably not strictly accurate when calculated to the acre.

* 84 was used in this average, since plot 86 was plainly anomalous in the large number of stalks produced.

We therefore suggest the following treatment as the best at present known for preventing stinking smut:

THE JENSEN HOT-WATER TREATMENT.

The hot-water treatment consists in immersing the seed which is supposed to be infected with smut, for a few minutes in scalding water. The temperature must be such as to kill the smut spores, and the immersion must not be prolonged so that the heat would injure the germ or embryo concealed within the seed-coats. If the water is at a temperature of 132° F., the spores will be killed, and yet the immersion, if not continued beyond fifteen minutes, will not in the least injure the seed. The smut spores will possibly be killed by ten minutes immersion. A fifteen-minute immersion, however, is recommended. The temperature must be allowed to vary but little from 132°; in no case rising higher than 135°, nor falling below 130°. To insure these conditions when treating large quantities of seed, the following suggestions are offered:

Provide two large vessels, as two kettles over a fire, or boilers on a cook-stove; the first containing warm water (say 110°–120°), the second containing scalding water (132°).

The first is for the purpose of warming the seed preparatory to dipping it in to the second. Unless this precaution is taken, it will be difficult to keep the water in the second vessel at a proper temperature. The seed to be treated must first be placed in a barrel or other large vessel filled with water, and be stirred till all the grains are wetted, and the smutted and imperfect ones rise to the surface. These must be removed by skimming. The grain may remain in the water fifteen minutes to half an hour. Then it must be removed and placed, a half-bushel or more at a time, in a vessel that will allow free entrance and exit of water on all sides. For this purpose a bushel basket made of heavy wire could be used, over which stretch wire netting, say 12 meshes to the inch; or an iron frame could be made at a trifling cost, over which the wire netting could be stretched. This would allow the water to pass freely, and yet prevent the passage of the seed. A sack made of loosely-woven material (as gunny-sack) could perhaps be used instead of the wire basket.

Now dip the basket of seed in the first vessel; after a moment lift it, and when the water has for the most part escaped, plunge it into the water again, repeating the operation several times. The object of the lifting and plunging, to which might be added also a rotary motion, is to bring every grain in contact with the hot water. Less than a minute is required for this preparatory treatment, after which plunge the basket of seed into the second vessel. If the thermometer indicates that the temperature of the water is falling, pour in hot water until it is elevated to 132°. If it should rise higher than 132°, add small quantities of cold water. This will doubtless be the most effectual method of keeping the proper temperature,* and requires only the addition of two small vessels—one for cold and the other for boiling water. The basket of seed should, very shortly after its immersion, be lifted, and then plunged and agitated in the manner described above; and the operation should be repeated eight to ten times during the immersion (which should be continued fifteen minutes). In this way every portion of the seed will be subjected to the action of the scalding water. Immediately after its removal dash cold water over it, or plunge it into a vessel of cold water, and then spread out to dry. Another portion can be treated similarly, and so on till all the seed has been disinfected.

The important precautions to be taken are as follows: 1st. *Maintain the proper temperature* of the water (132° Fahr.), in no case allowing it to rise higher than 135° or to fall below 130°. This will not be difficult to do if a reliable thermometer is used and hot or cold water be dipped into the vessel as the falling or rising temperature demands. Immersion fifteen minutes will not then injure the seed. 2d. See that the volume of scalding water is much greater (at least six or eight times) than that of the seed treated at any one time. 3d. Never fill the basket or sack containing the seed entirely full, but always leave room for the grain to move about freely. 4th. Leave the seed in the second vessel of water *fifteen minutes.*

SUMMARY.

The stinking smut of wheat is a destructive disease caused by two closely-allied, parasitic fungi called *Tilletia foetens* and *Tilletia Tritici.*

These two species of smut differ only in a few microscopic characters, and both produce the same disease.

The disease is spread by spores of these fungi adhering to the sound grains before they are planted, or perhaps rarely by spores present in the soil.

The damage from this disease is often very considerable, sometimes amounting to one-half to three-quarters of the whole crop.

In ordinary cases, the disease can be entirely prevented by soaking the seed 15 minutes in water heated to 132° F.

The other fungicides used, when decreasing the amount of smut, at the same time also interfered with the germination, and reduced the vigor of the plants.

Seed from clean fields (if the adjoining fields were not smutty) will produce a crop of wheat free from smut.

*Steam, conducted into the second vessel by a pipe provided with a stop-cock, answers very well both for heating the water and elevating the temperature from time to time.

EXPLANATION OF THE PLATE.

PLATE I.—STINKING SMUT OF WHEAT *(Tilletia foetens).*

Figures 1 and 2 were drawn one and one-third natural size, and were reduced in photo-engraving to natural size. Figures 3–8 were drawn with a magnification of 8 diameters, and were reduced to 6 diameters.

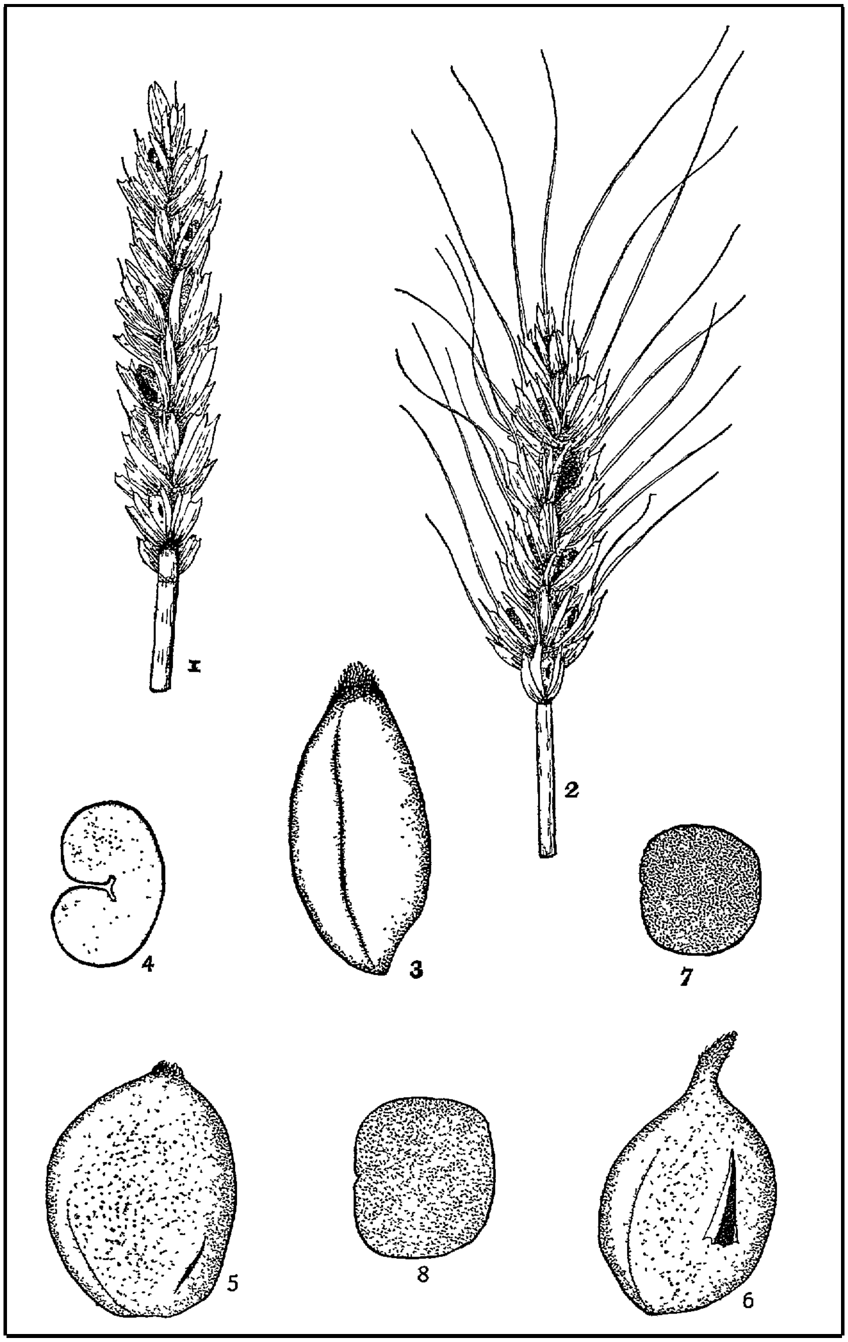
Fig. 1. Smooth wheat smut *(Tilletia foetens),* specimen from Indiana, a completely-smutted beardless head.

Fig. 2. Smooth wheat smut *(Tilletia foetens),* specimen from Iowa, a completely-smutted bearded head.

Fig. 3 and 4. Sound grains of wheat. Fig. 3 in profile; fig. 4 in section.

Fig. 5-8. Smutted grains of wheat. Figs. 5 and 6 in profile; figs. 7 and 8 in section.

BOTANICAL DEPARTMENT. PLATE I.



STINKING SMUT OF WHEAT.