

Proceedings of the Iowa Academy of Science

Volume 26 | Annual Issue

Article 34

1919

Studies upon the Absorption and Germination of Wheat Treated with Formaldehyde

A. L. Bakke
Iowa State College

H. H. Plagge
Iowa State College

Copyright ©1919 Iowa Academy of Science, Inc.

Follow this and additional works at: <https://scholarworks.uni.edu/pias>

Recommended Citation

Bakke, A. L. and Plagge, H. H. (1919) "Studies upon the Absorption and Germination of Wheat Treated with Formaldehyde," *Proceedings of the Iowa Academy of Science*, 26(1), 365-375.

Available at: <https://scholarworks.uni.edu/pias/vol26/iss1/34>

This Research is brought to you for free and open access by the Iowa Academy of Science at UNI ScholarWorks. It has been accepted for inclusion in Proceedings of the Iowa Academy of Science by an authorized editor of UNI ScholarWorks. For more information, please contact scholarworks@uni.edu.

STUDIES UPON THE ABSORPTION AND GERMINATION OF WHEAT TREATED WITH FORMALDEHYDE.

A. L. BAKKE AND H. H. PLAGGE.

Treating wheat with formaldehyde to prevent the covered or stinking smut of wheat is a general practice wherever wheat is grown. Henderson,¹ Burmester², Johnson³ and Brittlebank⁴ have submitted results of germination tests where wheat has been soaked for varying periods, with the purpose of obtaining safe limits where the fungus is killed, while the seed is left intact. Naturally this is the important conception from the practical standpoint. But admitting this to be the case there are still many fundamental propositions which are still open for solution and of equal import to the practical phases of grain treating to prevent smut and problems of imbibition and of germination.

While the authors were connected with the office of Cereal Investigations* of the U. S. Department of Agriculture they assisted in carrying on a campaign to prevent smut. This campaign consisted largely in giving demonstrations and discussions on smut and the means of prevention. Two outstanding propositions encountered were (1) the time for maximum absorption to take place, (2) the time in which seed can be kept in contact with formaldehyde and still give the highest per cent germination. In practically all cases wheat growers are advised to operate within the limits of safety but they are nevertheless desirous of knowing where the limits are. These facts then in themselves led the writers to submit the problems as suggested to a series of experiments, the results of which are given in this paper.

¹Henderson, F. L., Experiments with wheat and oats for smut. Idaho Agrl. Exp. Sta. Bul. 53, 1906.

²Burmester, H., Vergleichende Untersuchungen ueber den Einfluss der verschiedenen Samenheizmethoden auf die pilztotende Wirkung. Zitschr Pflanzenkrank. 18: 154-187, 1908.

³Johnson, J. C., Influence of "pickling" on the germination of cereals. Jour. Bd. Agr. (London) 20: 120-124, 1913.

⁴Brittlebank, C. C., The effect of formalin and copper sulphate on the germination of wheat. Jour. Dept. Agr. Victoria 11: 473-76, 2 figs. 1913.

*This work was under the immediate charge of Dr. G. M. Reed, then of the University of Missouri, but now with the U. S. Dept. of Agriculture, Office of Cereal Investigations.

In this study the purpose was to use a solution of formalin* such as is given to farmers and to use methods comparable so that comparisons could be more easily made. The method used through-

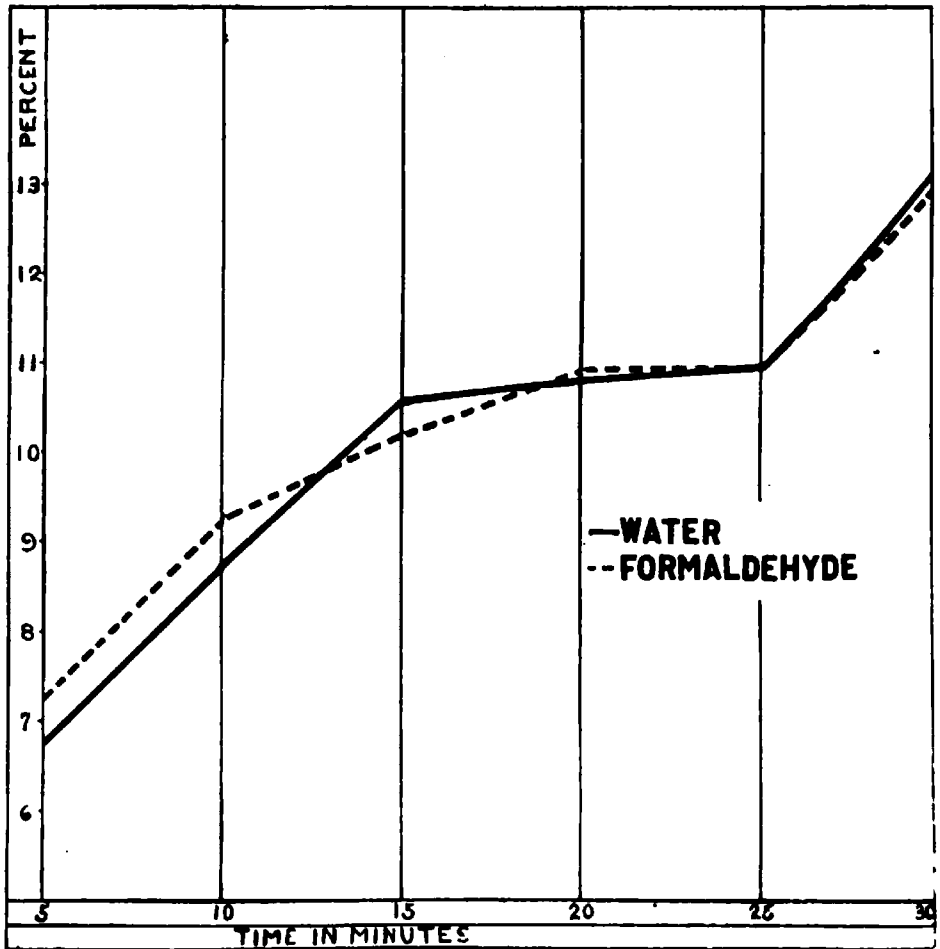


Fig. 96. Comparative difference in the absorption for wheat placed in a formalin solution and in distilled water for periods varying from five to thirty minutes.

out consisted in counting out 100 seeds of a uniform size, placing these in weighed, glass stoppered weighing bottles after which the weight of the seed was determined and finally the seed was again weighed after it had been subjected to the formaldehyde for a cer-

*The directions for treating wheat to prevent smut as given by Dr. G. M. Reed are as follows:

The solution used for treating stinking smut of wheat is made by using one pint or one pound of commercial formalin (guaranteed 40 per cent solution of formaldehyde) to forty gallons of water. One gallon of solution is sufficient to treat one bushel of grain. 1 Dipping—take two half barrels or tubs with holes and plugs near bottom. Place one tub on two saw horses and fill two-thirds full with the solution of formaldehyde. Pour slowly into this solution one-half to one bushel of wheat seed, stirring thoroughly for five to ten minutes so that the smut balls, trash, etc., will reach the surface. Skim this material off and drain this solution into the second tub. Pour the seed into a pile on the floor, exchange positions of tubs and repeat the operation. Cover the treated seed with sacks for four to ten hours. Sow at once or spread the seed out to dry.

WHEAT TREATED WITH FORMALDEHYDE

367

tain prescribed time. The seed was submerged into the formalin solution (1-320) for nine minutes; one minute was taken to pour off the solution. The grains were dried immediately by means of slips of filter paper, after the seeds had been placed in a 50 cc. porcelain crucible. When the seeds were sufficiently dry, so as not to adhere to sides of the crucible, they were returned to the weighing bottle and weighed. In all cases the bottle was rotated so as to be sure that none of the seeds would adhere. If they did they were dried further before being weighed. The germination was tested by the usual plate method, petri dishes being employed.

COMPARATIVE ABSORPTION

In the tests for comparative absorption 100 seeds were counted out, weighed, dried and again weighed as given above. In all cases the absorption for seeds placed in the formalin solution was compared directly with the absorption taking place in water; one set was handled by each of the writers. Five determinations of each were made. The data obtained are given in table I.

TABLE I
DATA GIVING THE PERCENTAGE OF ABSORPTION AND GERMINATION OF WHEAT WHICH HAS BEEN LEFT IN A FORMALIN SOLUTION AND IN WATER FOR PERIODS FROM 5 TO 30 MINUTES.

		WATER					FORMALDEHYDE									
		FIVE MINUTES					TEN MINUTES					FIFTEEN MINUTES				
No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent		
12	2.6150	.1784	6.82	98	14	2.4899	.1817	7.29	93							
6	2.5729	.1737	6.75	100	9	2.5634	.1926	7.51	95							
1	2.5550	.1735	6.79	98	29	2.5680	.1584	6.16	95							
27	2.5056	.1742	6.95	95	21	2.5179	.1971	7.82	95							
10	2.5254	.1688	6.68	95	5	2.3666	.1764	7.45	95							
Average	2.5567	.1737	6.79	97.20	Average	2.5011	.1812	7.24	94.60							
27	2.5369	.2241	8.83	94	14	2.5125	.2430	9.67	94							
24	2.4919	.2243	9.00	96	12	2.3351	.2213	9.47	90							
6	2.4746	.2286	9.23	93	26	2.6115	.2364	9.05	95							
5	2.4107	.1968	8.16	92	29	2.4179	.2260	9.34	93							
30	2.5134	.2195	8.73	96	5	2.6396	.2457	9.30	94							
Average	2.4855	.2186	8.79	94.20	Average	2.5033	.2344	9.36	93.40							
1	2.3977	.2514	10.48	93	14	2.4533	.2634	10.73	95							
9	2.4387	.2872	11.77	97	15	2.6094	.2785	10.67	94							
30	2.6668	.2870	10.76	97	29	2.6399	.2725	10.32	96							
21	2.5119	.2875	10.64	97	47	2.5748	.2620	10.17	95							
6	2.6498	.2530	9.54	89	26	2.6498	.2455	9.26	96							
Average	2.5529	.2692	10.63	96.60	Average	2.5854	.2643	10.23	95.20							

WHEAT TREATED WITH FORMALDEHYDE

TWENTY MINUTES

WATER				FORMALDEHYDE					
No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent.)	Germination in per cent	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent.)	Germination in per cent
12	2.5807	.2626	10.17	96	29	2.5743	.2793	10.84	97
5	2.4511	.2652	10.81	96	24	2.5975	.2897	11.15	99
26	2.5870	.2864	11.07	98	29	2.4348	.2607	10.71	97
5	2.3981	.2722	11.35	97	47	2.5335	.2749	10.85	96
30	2.4469	.2642	10.79	97	14	2.4865	.2793	11.23	98
Average	2.4927	.2701	10.83	96.80	Average	2.5253	.2767	10.95	97.40

TWENTY-FIVE MINUTES

24	2.5950	.2778	10.70	98	9	2.5237	.2661	10.54	97
12	2.6828	.2999	11.17	97	6	2.6731	.3071	11.48	98
30	2.7730	.3150	11.35	98	47	2.5538	.2812	11.01	95
29	2.5271	.2766	10.94	99	26	2.6021	.2882	11.07	98
5	2.7284	.2844	10.81	98	27	2.6300	.2865	10.89	97
Average	2.6612	.2907	10.99	98	Average	2.5965	.2841	10.99	97

THIRTY MINUTES

26	2.3422	.3193	13.63	97	29	2.4561	.3299	13.43	96
6	2.3918	.3014	12.60	99	24	2.3970	.3141	13.10	99
21	2.5012	.3258	13.02	98	1	2.4650	.3262	13.23	98
27	2.4432	.3041	12.44	96	9	2.3548	.3046	12.93	98
47	2.3473	.3336	13.78	98	12	2.5510	.3148	12.34	98
Average	2.4051	.3168	13.09	97.60	Average	2.4447	.3179	13.00	97.80

From an examination of the data and of the graph, figure 96, it is apparent that the absorption by wheat placed in a formalin solution and in water does not vary materially during a period of thirty minutes. At the end of ten minutes greater absorption is present in the seed placed in the formaldehyde but a reversal is present at the end of fifteen minutes as seed in distilled water increases in weight to a greater extent. However, after fifteen minutes imbibition is approximately the same.

The second part of this series of investigations was confined to a study of the time of exposure to formaldehyde necessary to cause a fall in the percentage of germination. The general plan then is the same as has been previously set forth. The seeds were retained in the glass stoppered containers after the formalin solution had been poured off for varying periods from one to thirty-six hours, when they were weighed. The data are given in table II.

TABLE II.

DATA GIVING PERCENTAGE OF ABSORPTION AND GERMINATION FOR WHEAT SUBJECTED TO FORMALDEHYDE FOR VARYING PERIODS FROM ONE TO THIRTY-SIX HOURS.

Period of covering No. hours	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent
1	115	2.3473	.4585	19.53	97
	110	2.5556	.4631	18.12	98
1	Average	2.4514	.4608	18.83	97.50
2	113	2.4432	.5680	23.24	97
	111	2.4100	.5708	23.68	95
2	Average	2.4266	.5694	23.46	96
3	114	2.4329	.6143	25.24	95
	109	2.5014	.6588	26.33	97
3	Average	2.4671	.6365	25.79	96
4	108	2.5394	.7478	29.44	97
	102	2.6215	.4835	18.44	91
4	Average	2.5805	.6157	23.94	94
5	107	2.5935	.7940	30.61	94
	106	2.6563	.8331	31.36	95
5	Average	2.6249	.8136	30.99	94.50

WHEAT TREATED WITH FORMALDEHYDE

371

TABLE No. II—Continued

Period of covering No. hours	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent
6	103	2.3835	.7981	33.48	92
6	105	2.5668	.8261	32.18	93
6	Average	2.4752	.8121	32.83	92.50
7	112	2.3682	.6207	26.20	95
7	104	2.5474	.9954	39.07	95
7	Average	2.4578	.8081	32.64	95
8	101	2.5009	.8798	35.17	93
8	117	2.5234	.8360	33.12	95
8	Average	2.5122	.8579	34.15	94
9	118	2.5234	.8360	36.75	95
9	116	2.5692	.7204	28.03	96
9	Average	2.5463	.7782	32.39	95.5
10	5	2.2341	.6121	26.22	95
10	6	2.5270	.8483	33.56	94
10	Average	2.3806	.7302	29.89	94.5
11	16	2.4843	.9369	37.71	95
11	2	2.6077	1.0726	41.13	93
11	Average	2.5460	1.0048	39.42	94
12	8	2.4400	.8681	35.57	95
12	94	2.3856	.9971	41.79	90
12	Average	2.4128	.9326	38.68	92.5
13	5	2.5289	.7913	31.29	95
13	13	2.5600	.8456	33.03	95
13	Average	2.5446	.8185	32.16	95
14	4	2.6222	.9838	39.80	94
14	19	2.4553	1.0592	43.13	88
14	Average	2.5388	1.0215	41.47	91
15	17	2.3625	.8029	33.98	95
15	20	2.4310	.8635	35.52	94
15	Average	2.3968	.8332	34.75	94.50
16	92	2.4404	.7557	30.96	95
16	93	2.5197	.7170	28.45	93
16	Average	2.4801	.7364	29.72	94

TABLE No. II—Continued

Period of covering No. hours	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent
17	18	2.5388	1.0640	41.95	90
17	93	2.5026	.8842	35.33	94
17	Average	2.5207	.9741	38.64	92
18	27	2.5468	.6807	26.72	95
18	17	2.4357	1.0331	42.41	91
18	Average	2.4913	.8569	34.57	93
19	31	2.4698	.7985	32.33	93
19	16	2.5107	.7364	29.33	95
19	Average	2.4903	.7675	30.83	94
20	36	2.5078	1.0095	40.25	93
20	33	2.4919	.6941	27.76	93
20	Average	2.4999	.8518	34.01	93
21	3	2.5474	.9075	35.62	95
21	7	2.5186	.8248	32.74	96
21	Average	2.5330	.8662	34.18	95.50
22	91	2.5615	.7420	28.96	96
22	1	2.4949	1.0031	40.20	93
22	Average	2.5282	.8726	34.58	94.5
23	35	2.5740	.9115	35.41	94
23	7	2.5182	.5304	21.06	91
23	Average	2.5461	.7210	28.24	92.5
24	5	2.5441	.8386	32.96	92
24	10	2.5438	.7312	28.74	92
24	Average	2.5440	.7849	30.85	92
25	10	2.4175	.7962	32.93	93
25	21	2.3756	.7352	30.94	92
25	Average	2.3966	.7657	31.94	92.50
26	47	2.6136	.8485	32.46	95
26	12	2.5559	.6696	26.19	96
26	Average	2.5848	.7591	29.33	95.50
27	21	2.5104	.7857	31.29	90
27	37	2.5610	.8202	32.02	87
27	Average	2.5357	.8030	31.66	88.50

WHEAT TREATED WITH FORMALDEHYDE

373

TABLE No. II—Continued

Period of covering No. hours	No. of bottle	Weight of 100 seeds (grams)	Increase in weight (grams)	Increase in weight (per cent)	Germination in per cent
28	39	2.4354	.7926	32.54	93
28	27	2.5680	.9725	37.86	94
28	Average	2.5017	.8826	35.20	93.50
29	20	2.5008	.8275	33.08	91
29	14	2.4822	.8027	32.33	89
29	Average	2.4915	.8151	32.71	90
30	28	2.3997	1.0605	44.18	83
30	29	2.5760	.9780	37.96	87
30	Average	2.4879	1.0193	41.07	85
31	14	2.5831	.6001	23.23	93
31	30	2.5459	.8884	34.89	94
31	Average	2.5645	.7443	29.06	93.5
32	6	2.5014	.9063	36.23	88
32	14	2.5130	.8588	34.17	86
32	Average	2.5072	.8826	35.20	87
33	41	2.3707	.6947	29.30	88
33	6	2.3482	.6406	27.27	87
33	Average	2.3595	.6677	28.29	87.50
34	24	2.5043	1.1810	47.15	75
34	19	2.4343	.7861	32.29	86
34	Average	2.4693	.9836	39.72	80.5
35	21	2.5324	.7485	29.55	88
35	9	2.3512	.8287	35.24	77
35	Average	2.4418	.7886	32.40	83
36	26	2.5362	1.0178	40.13	83
36	5	2.4577	.8541	34.75	84
36	Average	2.4970	.9360	37.44	83.50

By examining the data and the graph, figure 97, it is plainly discernible that absorption is the most rapid at the beginning, being 18.83 per cent at the end of the first hour; from that point there is a gradual increase until the maximum, 41.47 per cent at the fourteenth hour is attained. At no subsequent period is there as high a percentage registered.

As far as the percentage germination is concerned there is no recognized drop until after the seeds have been exposed to formal-

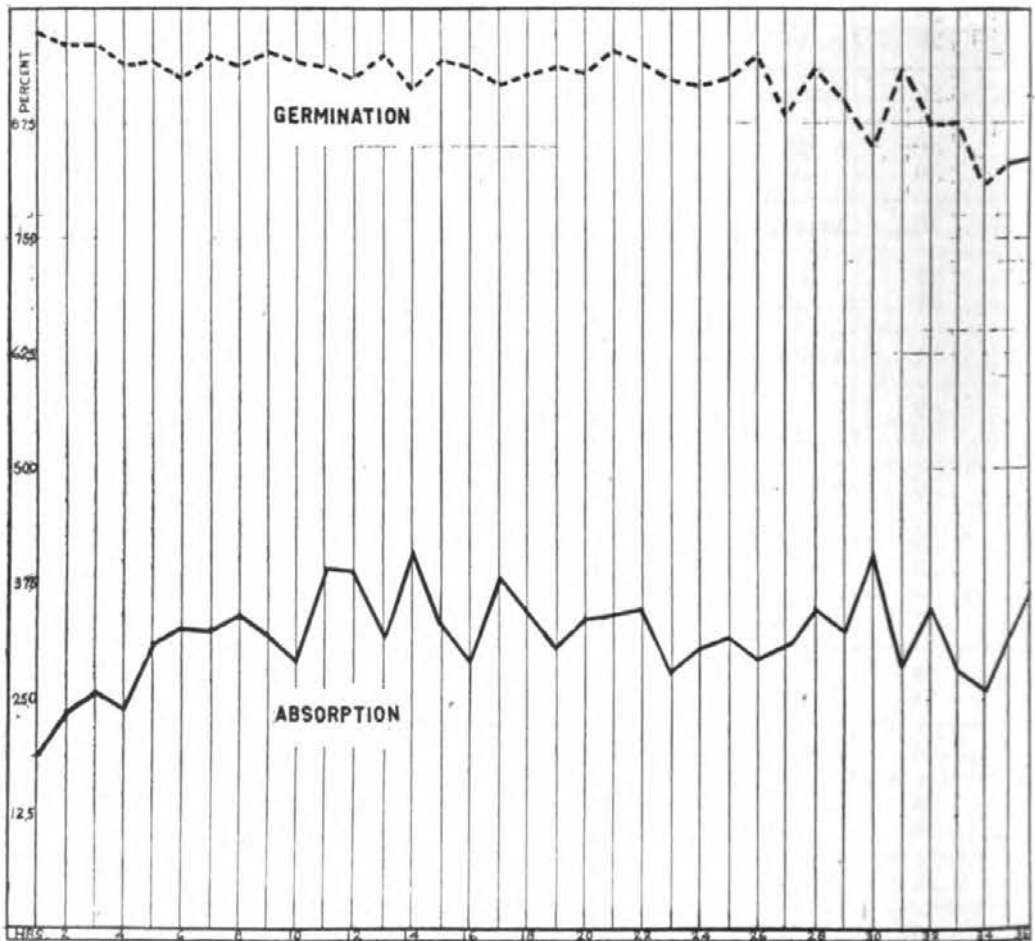


FIG. 97.—Diagram showing absorption and germination of wheat.

dehyde for a period of twenty-six hours. Although at the thirty-first hour the percentage germination rises again and is higher than for some of the earlier periods, yet it does not attain a percentage as high as has been delineated. However, there is a decided drop from the thirty-first hour. At the end of thirty-six hours the percentage of germination is only 83.5. It is regrettable that the series was not carried on further. Even though this feature of the experi-

ment was not planned for at the time the experiment was started, the results show that an extension of time would give a graph similar to the temperature curve of Lehenbauer⁵ for corn and the life phase curve of Buchanan⁶ for a bacterial culture. But as this is beyond the scope and province of the present studies it is advisable to postpone the submission of possible reactions until definite data have been obtained.

From the results presented in this paper it is evident:

1. That the absorption in the case of wheat seed placed in contact with formaldehyde in the usual concentration for treating seed to prevent smut is not materially different from wheat seed placed in water for the same period of time.

2. Wheat seed soaked in a formalin solution for ten minutes and kept enclosed for varying periods from one to thirty-six hours does not show any impaired germination until after twenty-six hours.

⁵Lehenbauer, P. A., Growth of maize seedlings in relation to temperature: *Physiol. Researches* 1: 247-288, 1914.

⁶Buchanan, R. E., Life phases in a bacterial culture: *Jour. Infect. Dis.* 23: 3-19, 1918.

IOWA STATE COLLEGE,
AMES, IOWA.