

EXPERIMENT STATION
OF THE
KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN.

BULLETIN NO. 41—DECEMBER, 1893.

BOTANICAL DEPARTMENT.

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THE EFFECT OF FUNGICIDES UPON THE GERMINATION
OF CORN.

THE treatment of various seeds with fungicides for the prevention of plant diseases is becoming more common as our knowledge of the life history of the numerous injurious parasitic fungi becomes more extended. It is clear that in those cases where chemicals are used to destroy fungous spores attached to the seed, the latter should pass through the treatment with as little loss of germinating power as possible. It is the object of the experiments detailed in the present bulletin to determine the effect upon the germinating power of seeds produced by treatment with such chemicals as are likely to be used as fungicides. The treatment usually employed, adopted here as reported in the following pages, is that of soaking the seed for a definite period in a solution of some chemical of known strength. It is obvious that seeds with thick seed coats would resist the action of a solution by virtue of the protective coating. Since it was the purpose to show the effect of the chemicals upon the vital processes in the seed rather than the resistance of the seed coat, such seeds were chosen as would readily absorb the chemicals. A comparison of the seeds of corn, wheat, pumpkin,

lettuce, mustard, alfalfa, tomato and castor bean showed that the effect was practically the same on all, such differences as there were being due to the differences in resisting powers of the seed coats; consequently, corn was chosen for the series of experiments detailed, as it answers better than the others to the necessary requirements. The seeds are large enough to be conveniently handled, they absorb liquids readily, and the germinating power is quite constant, being usually 100 per cent.

The corn used was of the ordinary dent variety grown upon the College farm. A certain number of perfect grains were counted out and placed in the solution of the chemical to be tested. After remaining for the required length of time, they were rinsed with water and planted in moist sand in zinc germinating pans, being covered with glass to prevent the ravages of mice. With every experiment, an equal number of grains were soaked in water for the same length of time, and planted alongside the others as a check. Enough liquid was always taken to entirely cover the seeds after swelling, and the vessels were kept covered to prevent the concentration of the solution by evaporation. The chemicals were mostly chemically pure, but in no case was there sufficient impurity to interfere with the result. The strength of the solution was based upon the crystallized substance where that is the usual condition; that is, 10 per cent. copper sulphate means 10 parts, by weight, of the crystallized material dissolved in 90 parts, by weight, of water.

The record of germination was kept by noting each morning those plants which appeared above the surface of the sand, the grains having been planted about one-half inch deep.

In the following table, the headings of the columns will explain themselves. In the fifth column is given the date on which the grains soaked in water appeared. In cases where all the grains did not germinate at the same time, two dates are given, one for the appearance of the first plants, and the other for the last. In column four, the number before the dash denotes the month, and that after the dash the day of the month. In all the succeeding columns, the number before the dash indicates the day of the month, and that after the dash the whole number of grains which had germinated up to that date.

In a few cases, the number of grains used in the trial is other than 20. In the trial with aluminum sulphate and zinc chloride, 10 per cent. for 24 hours, the number was 10. In a trial made March 7, with several chemicals, the number of grains soaked in water was 50, and the number soaked in the chemicals was 25. As indicated by the dots, the check in water was omitted in a few cases.

The potassium and sodium sulphides, being the commercial articles, are of variable composition. The copper acetate was made by treating 10 grams of the crystals with 90 grams of water, and using the soluble portion full strength (*a*), and half strength (*b*).

| Name of chemical used. | Strength, per cent. | No. hours soaked... | Date of putting to soak..... | Date and amount of germination of check..... | Date and amount of germination. |
|--|--|--|--|---|---|
| Acetic acid. | 5 | 24 | 5-16 | 25-20 | 0 |
| Alcohol, common. | 5 10 | 48 24 | 9-23 3-30 | 28-11, 30-17 4-17, 19-20 | 29-3, 30-6, 1-8, 3-10 4-19, 5-20 |
| Alcohol, methyl. | 5 10 | 24 24 | 6-28 5-18 | 2-20 25-20 | 2-20 0 |
| Aluminum sulphate. | 5 10 10 10 10 | 72 24 48 72 | 11-7 3-17 7-20 10-10 | 14-5, 21-17 22-6, 25-10 26-20 13-13, 15-20 | 15-6, 16-8, 23-9, 30-10, 3-11 22-1, 23-6, 24-9 26-17 14-1, 17-3, 25-4 |
| Aluminum ammonium sulphate. | 10 10 | 24 48 | 8-29 9-23 | 3-15, 5-19 28-11, 30-17 | 3-14, 5-19, 9-20 28-2, 29-8, 30-13, 7-14 |
| Aluminum potassium sulphate. (Common alum.) | 10 10 10 10 10 | 24 24 48 72 96 | 5-26 4-13 7-11 10-10 11-2 | 31-20 19-20 13-13, 15-20 10-3, 16-17 | 31-20 19-20 15-20 13-2, 14-14, 15-16, 18-17, 19-18, 21-19 7-2, 8-7, 9-13, 10-18, 11-20 |
| Ammonium carbonate. | 10 | 24 | 6-17 | 21-20 | 0 |
| Ammonium chloride. (Sal ammoniac.) | 5 10 10 10 | 48 48 48 72 | 11-21 5-21 7-13 10-10 | 28-20 18-16, 20-17 13-13, 15-20 | 28-4, 29-5, 30-8, 1-9 28-19, 4-20 20-1, 21-2, 26-3 17-2 |
| Ammonium hydrate. (Ammonia water.) | 10 | 24 | 8-29 | 3-15, 5-19 | 0 |
| Ammonium nitrate. | 10 10 | 24 48 | 6-23 11-21 | 27-20 | 28-3, 29-7, 2-8, 5-9 2-1 |
| Ammonium oxalate. | 10 | 24 | 8-29 | 3-15, 5-19 | 3-3, 5-5, 6-8 |
| Ammonium sulphocyanide. | 5 10 | 24 24 | 11-24 6-16 | 21-20 | 3-1, 5-5, 8-7, 10-9 0 |
| Ammonium ferrous sulphate. | 10 10 | 24 48 | 8-5 9-23 | 9-20 28-11, 30-17 | 9-18, 11-19 0 |
| Arsenous oxide. (White arsenic.) | 1 3 5 8 16 1 3 5 8 1 1 1 1 1 2 2 2 2 2 | 1 3 5 8 16 1 3 5 8 1 3 5 8 1 3 5 8 24 | 6-3 6-3 6-3 6-6 6-3 6-3 6-3 6-6 6-2 6-3 6-3 6-3 6-3 6-3 6-3 6-3 6-3 6-6 5-16 | 10-11, 13-15 8-17, 10-20 8-20 10-11, 12-14 10-12, 12-19 10-11, 13-15 8-17, 10-20 8-20 10-11, 12-14 10-11, 13-15 8-17, 10-20 8-20 10-11, 12-14 10-11, 13-15 8-17, 10-20 8-20 10-11, 12-14 10-11, 13-15 8-17, 10-20 8-20 10-11, 12-14 10-11, 13-15 8-17, 10-20 8-20 10-11, 12-14 25-20 | 10-1, 12-5 10-4, 12-8, 16-9 0 0 0 10-11, 12-12, 13-13 12-1 0 0 14-1 0 0 0 0 0 0 10-1 0 0 0 |
| Barium chloride. | 5 10 10 10 10 | 72 24 48 48 72 | 11-7 3-7 5-21 7-18 10-10 | 14-5, 21-17 16-47 28-20 22-20 13-13, 15-20 | 30-1 14-3, 15-19, 16-22, 17-23, 18-25 28-20 20 22-2, 26-19 14-9, 15-12, 17-15 |

RECORD — CONTINUED.

| Name of chemical used. | Strength, per cent | No. hours soaked. | Date of putting to soak | Date and amount of germination of check. | Date and amount of germination. |
|---|--------------------|-------------------|-------------------------------|---|---|
| Boric acid. | 2 | 24 | 11-26 | ..... | 5-17 |
| | 96 | 24 | 11-23 | ..... | 0 |
| | 4 | 24 | 8-29 | 3-15, 5-19 | 0 |
| Cadmium bromide. * *S stands for cold, saturated solution. | 1/20 S | 3 | 6-21 | 26-20 | 26-20 |
| | 1/20 S | 8 | 6-21 | 26-15, 29-18 | 26-19, 29-20 |
| | 2/20 S | 16 | 6-21 | 26-16 | 26-14, 29-15 |
| | 3/20 S | 24 | 6-21 | 27-15 | 0 |
| | 4/20 S | 3 | 6-21 | 26-20 | 26-18, 29-19 |
| | 5/20 S | 8 | 6-21 | 26-15, 29-18 | 26-17, 27-19 |
| | 6/20 S | 16 | 6-21 | 26-16 | 26-1, 27-2 |
| | 7/20 S | 24 | 6-21 | 27-15 | 0 |
| | 8/20 S | 3 | 6-21 | 26-20 | 26-17 |
| | 9/20 S | 8 | 6-21 | 26-15, 29-18 | 26-3, 27-12, 29-13 |
| | 10/20 S | 16 | 6-21 | 26-16 | 26-2 |
| | 11/20 S | 24 | 6-21 | 27-15 | 0 |
| | 12/20 S | 3 | 6-21 | 26-20 | 26-13 |
| | 13/20 S | 8 | 6-21 | 26-15, 29-18 | 27-1, 29-2 |
| | 14/20 S | 16 | 6-21 | 26-16 | 26-1, 27-2, 29-3 |
| 15/20 S | 24 | 6-21 | 27-15 | 0 | |
| Cadmium sulphate. | 5 | 24 | 11-16 | ..... | 2-18, 8-19 |
| | 5 | 96 | 11-23 | ..... | 0 |
| | 10 | 24 | 8-5 | 9-20 | 9-3, 10-4 |
| Calcium chloride. | 10 | 24 | 4-13 | 19-20 | 19-10, 23-11, 26-12 |
| | 10 | 24 | 5-26 | 31-20 | 31-20 |
| | 10 | 48 | 7-13 | 13-16, 20-17 | 19-4, 20-12, 21-13, 22-15 |
| | 10 | 48 | 11-21 | ..... | 28-11, 29-15, 30-17 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 14-3, 15-13, 17-17, 18-18, 21-19 |
| Calcium hydrate. (Lime water.) | 2 | 24 | 5-23 | 28-20 | 28-20 |
| | 2 | 24 | 4-13 | 19-20 | 19-20 |
| | 2 | 48 | 7-18 | 22-20 | 22-12, 26-18 |
| | 2 | 72 | 11-7 | 14-5, 21-17 | 14-4, 15-15, 19-16 |
| | 2 | 72 | 10-10 | 13-13, 15-20 | 13-6, 14-18, 15-20 |
| Chromic acid. | 1 | 48 | 9-23 | 28-11, 30-17 | 29-6, 30-9, 1-11, 3-15 |
| Chromium potassium sulphate. (Chrome alum.) | 10 | 24 | 6-15 | 20-20 | 20-20 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 14-2, 15-10, 17-18, 22-19 |
| | 10 | 96 | 11-2 | 10-3, 16-17 | 14-2, 21-5 |
| Cobalt nitrate. | 5 | 24 | 11-9 | ..... | 17-10, 19-14, 28-15, 31-16 |
| | 10 | 24 | 5-23 | 28-20 | 28-20 |
| | 10 | 48 | 7-19 | 26-27 | 26-1 |
| Copper acetate. (Verdigris.) | b | 24 | 6-24 | 28-20 | 0 |
| | a | 24 | 5-12 | 6-20 | 0 |
| Copper chloride. | 5 | 48 | 11-21 | ..... | 1-3, 5-5 |
| | 10 | 24 | 3-14 | 23-24 | 21-1, 22-2, 23-6, 24-17, 25-20, 28-22, 2-24 |
| | 10 | 48 | 5-29 | 3-14, 5-19 | 8-1 |
| Copper nitrate. | 10 | 24 | 3-14 | 23-24 | 22-1, 23-2, 24-6, 25-12, 26-14, 28-16, 2-20 |
| | 10 | 24 | 5-17 | 25-20 | 25-1, 26-7, 28-16 |
| | 10 | 48 | 11-21 | ..... | 1-1, 3-3, 5-4, 8-7, 12-8, 19-10 |
| Copper sulphate. (Blue vitriol.) | 5 | 48 | 11-21 | ..... | 29-8 |
| | 10 | 24 | 3-14 | 23-24 | 23-12, 24-17 |
| | 10 | 24 | 6-24 | 28-20 | 29-2, 2-3 |
| | 10 | 48 | 5-21 | 28-20 | 28-15, 8-16 |
| | 10 | 48 | 8-29 | 3-14, 5-19 | 5-3, 6-4, 10-5 |
| | 10 | 72 | 11-7 | 14-15, 21-17 | 15-1, 17-4, 19-5, 23-9 |
| Ferric chloride. (Chloride of iron.) | 10 | 24 | 3-7 | 16-47 | 15-10, 16-24, 17-25 |
| | 10 | 48 | 7-19 | 26-20 | 26-19 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 14-2, 15-6, 16-7, 21-8, 30-11 |

RECORD—CONTINUED.

| Name of chemical used. | Strength, per cent | No. hours soaked. | Date of putting to soak. | Date and amount of germination of check. | Date and amount of germination. |
|--|--------------------|-------------------|--------------------------|--|-------------------------------------|
| Ferrous sulphate. (Green vitriol.) | 10 | 24 | 3-7 | 16-47 | 14-21, 15-22, 16-27, 17-24 |
| | 10 | 48 | 7-19 | 28-20 | 26-20 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 14-1, 15-13, 16-14, 19-15, 21-17 |
| Ferricpotassium sulphate. (Iron alum.) | 10 | 24 | 9-9 | 14-16, 16-17 | 15-5, 16-18, 17-19 |
| | 10 | 48 | 9-23 | 28-11, 30-17 | 28-4, 29-8, 30-9, 1-10 |
| | 10 | 48 | 11-21 | ..... | 28-20 |
| Hydrochloric acid. | 5 | 24 | 5-14 | 18-11, 19-20 | 18-2, 19-6, 20-7, 21-11 |
| | 5 | 24 | 6-27 | 30-20 | 30-5, 1-15, 2-17 |
| Lead acetate. (Sugar of lead.) | 10 | 24 | 5-12 | 16-20 | 18-17, 19-20 |
| | 10 | 48 | 8-29 | 3-14, 5-19 | 3-1, 5-8, 6-11, 7-13, 8-14, 9-18 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 14-1, 15-3, 16-5, 19-6, 30-9 |
| Lead nitrate. | 10 | 24 | 3-7 | 16-47 | 14-6, 15-25 |
| | 10 | 48 | 8-29 | 3-14, 5-19 | 5-10, 6-11, 7-14, 8-15, 9-19 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 15-2, 17-3, 19-4, 24-9, 30-11, 3-12 |
| Magnesium chloride. | 10 | 24 | 3-7 | 16-47 | 14-4, 15-20, 16-24, 17-25 |
| | 10 | 48 | 7-13 | 18-16, 20-17 | 19-10, 20-17, 21-18, 22-19 |
| | 10 | 96 | 11-2 | 10-3, 16-17 | 8-2, 9-6, 10-12, 11-15, 14-16 |
| Magnesium sulphate. (Epsom salts.) | 10 | 24 | 4-13 | 19-20 | 19-20 |
| | 10 | 24 | 5-26 | 31-20 | 31-20 |
| | 10 | 48 | 11-21 | ..... | 28-19 |
| | 10 | 48 | 7-13 | 18-16, 20-17 | 18-16, 19-18, 20-20 |
| | 10 | 96 | 11-2 | 10-3, 16-17 | 11-3, 12-7, 14-14, 15-17, 16-18 |
| Manganese sulphate. | 10 | 24 | 6-14 | 20-20 | 20-19 |
| | 10 | 48 | 7-19 | 26-20 | 26-20 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 15-2, 17-8, 19-9 |
| Mercuric chloride. (Corrosive sublimate.) | $\frac{1}{10}$ | 1 | 3-4 | 8-11, 11-20 | 8-3, 9-20 |
| | $\frac{1}{10}$ | 3 | 3-4 | 8-5, 9-20 | 9-16, 11-17 |
| | $\frac{1}{10}$ | 5 | 3-4 | 8-3, 10-20 | 9-18 |
| | $\frac{1}{10}$ | 8 | 3-6 | 10-19 | 10-20 |
| | $\frac{1}{10}$ | 16 | 3-8 | 11-20 | 11-3 |
| | $\frac{1}{10}$ | 24 | 8-5 | 9-20 | 0 |
| | $\frac{1}{10}$ | 72 | 10-10 | 13-13, 15-20 | 13-2, 14-10, 15-16, 17-17 |
| | $\frac{2}{10}$ | 24 | 11-7 | ..... | 17-11, 19-12, 21-13 |
| | $\frac{1}{2}$ | 24 | 6-28 | 2-20 | 0 |
| | 1 | 1 | 3-4 | 8-11, 11-20 | 9-18, 11-19 |
| | 1 | 3 | 3-4 | 8-5, 9-20 | 10-2 |
| | 1 | 5 | 3-4 | 8-3, 10-20 | 9-3 |
| | 1 | 8 | 3-6 | 10-19 | 11-1, 13-2, 15-3 |
| | 1 | 24 | 5-14 | 19-20 | 0 |
| | 3 | 1 | 3-8 | 11-12, 13-20 | 0 |
| | 3 | 3 | 3-8 | 11-20 | 0 |
| | 3 | 5 | 3-8 | 11-1, 13-20 | 0 |
| 3 | 8 | 3-8 | 11-1, 13-20 | 0 | |
| 6 | 1 | 3-8 | 11-12, 13-20 | 0 | |
| 6 | 3 | 3-8 | 11-20 | 0 | |
| 6 | 5 | 3-8 | 11-1, 13-20 | 0 | |
| 6 | 8 | 3-8 | 11-1, 13-20 | 0 | |
| Nitric acid. | 2 | 24 | 3-30 | 4-17, 19-20 | 4-13, 5-15, 8-17, 11-18 |
| | 5 | 24 | 3-16 | 25-20 | 0 |
| Nickel chloride. | 5 | 24 | 11-24 | ..... | 1-1, 2-14, 5-18 |
| | 10 | 24 | 8-5 | 9-20 | 0 |
| Nickel sulphate. | 5 | 48 | 11-21 | ..... | 3-2, 15-4 |
| | 10 | 24 | 6-14 | 20-20 | 20-18 |
| | 10 | 48 | 7-20 | 26-20 | 26-7 |
| Phosphoric acid. | 5 | 96 | 11-23 | ..... | 1-4, 2-6, 28-8 |
| | 10 | 24 | 8-29 | 3-15, 5-19 | 3-10, 5-15, 9-16 |
| | 10 | 48 | 11-21 | ..... | 8-2, 19-3 |

RECORD — CONTINUED.

| Name of chemical used. | Strength, per cent. | No. hours soaked. | Date of putting to soak | Date and amount of check | Date and amount of germination. |
|---|--|---|--|--|---|
| Picric acid. | 5 | 24 | 8-5 | 9-20 | 6 |
| Potassium acetate. | 5 10 10 10 | 72 24 72 96 | 11-7 6-14 10-10 11-2 | 14-5, 21-17 20-20 13-13, 15-20 10-3, 16-17 | 17-6, 24-7, 30-8 20-20 14-3, 15-6, 17-13, 25-14 11-2, 12-3, 14-6, 15-7 |
| Potassium bromide. | 10 10 | 24 48 | 6-17 11-21 | 21-20 | 22-2, 23-20 29-2, 30-4, 1-5, 2-7, 5-8 |
| Potassium bichromate. | 5 5 10 | 24 24 24 | 10-8 11-5 3-28 | 12-6, 13-18 11-5, 14-19 5-20 | 13-1, 14-3, 15-5, 17-7 14-9, 15-15, 16-16, 19-17 6-12, 8-20 |
| Potassium chlorate. | 5 5 5 10 10 | 24 24 24 24 24 | 11-10 11-9 10-8 6-16 6-15 | 17-11, 19-17 12-6, 13-18 21-20 20-20 | 17-3, 19-12, 28-13 17-10, 20-11, 21-14, 28-17 13-10, 14-15, 15-17, 17-19 23-2 20-3, 22-7, 23-9, 24-10 |
| Potassium chloride. | 2½ 5 10 | 24 24 24 | 11-5 10-8 9-9 | 11-5, 14-19 12-6, 13-18 14-6, 16-17 | 14-16, 15-17, 26-18 13-15, 14-17 16-7, 17-12, 20-15 |
| Potassium chromate. | 2½ 5 10 | 24 24 24 | 11-5 10-8 6-23 | 11-5, 14-19 12-6, 13-18 27-20 | 14-11, 15-13, 16-15, 25-16 13-3, 14-10, 15-13, 17-14, 27-15 28-2, 30-4, 1-5, 5-6, 7-8, 8-9 |
| Potassium cyanide. | 1 3 5 8 16 24 1 1 1 1 1 1 1 1 1 1 5 5 5 5 5 5 10 10 10 10 10 20 20 20 20 | 1 3 5 8 16 24 1 1 1 1 1 1 1 1 1 5 5 5 5 5 5 10 10 10 10 10 20 20 20 20 | 7-18 4-18 4-19 4-19 4-18 4-18 7-18 4-18 4-19 4-19 4-18 4-18 4-18 4-18 7-18 4-18 4-19 4-19 4-19 4-18 10-8 7-18 4-18 4-19 4-19 4-19 4-18 10-8 7-18 4-18 4-19 4-19 4-19 4-18 4-19 4-19 4-19 4-19 | 24-20 26-13, 3-18 26-12, 1-14 26-20 26-13, 28-16 26-18 24-20 26-15, 3-18 26-12, 29-13 26-20 26-18 24-20 26-12, 2-13 26-5, 27-8, 28-9 26-3, 27-13, 29-14 26-2, 28-7, 1-8, 4-9 29-1, 1-2 24-17, 25-20 26-14, 27-17, 29-18 27-9, 28-13, 1-14, 2-15, 6-16 26-1, 27-7, 29-8, 1-11 26-1, 6-2 0 24-17, 25-20 26-5, 27-10, 6-11 26-4, 27-7, 2-8, 3-9 27-2, 28-5, 1-6 0 24-10, 25-11, 26-13 26-1, 27-5, 28-6, 1-10, 3-11 28-1, 1-5, 2-6, 6-8 27-2, 1-4 | 24-20 26-13, 2-15 26-9, 27-12, 28-13 26-16, 27-18 26-12, 28-13, 2-14 26-11, 28-17, 29-18 24-18, 25-20 26-12, 2-13 26-5, 27-8, 28-9 26-3, 27-13, 29-14 26-2, 28-7, 1-8, 4-9 29-1, 1-2 24-17, 25-20 26-14, 27-17, 29-18 27-9, 28-13, 1-14, 2-15, 6-16 26-1, 27-7, 29-8, 1-11 26-1, 6-2 0 24-17, 25-20 26-5, 27-10, 6-11 26-4, 27-7, 2-8, 3-9 27-2, 28-5, 1-6 0 24-10, 25-11, 26-13 26-1, 27-5, 28-6, 1-10, 3-11 28-1, 1-5, 2-6, 6-8 27-2, 1-4 |
| Potassium ferricyanide. | 5 | 24 | 10-18 | 12-6, 13-18 | 13-6, 14-12, 15-13 |
| Potassium ferrocyanide. | 10 | 24 | 10-8 | 12-6, 13-18 | 13-1, 14-5, 15-6, 17-7, 19-9 |
| Potassium hydrate. (Caustic potash.) | 1 3 5 8 16 24 24 1 1 1 | 1 3 5 8 16 24 24 1 1 1 | 5-6 5-6 5-6 5-6 5-6 5-6 5-6 10-8 1-1 1-1 3-3 | 12-16, 13-20 12-16, 13-20 12-20 12-18, 13-19 12-20 12-20 12-20 12-6, 13-18 12-16, 13-20 12-16, 13-20 12-16, 13-20 | 12-7, 13-15, 15-17 12-6, 13-19, 15-20 12-17, 13-19 12-14, 13-18 12-2, 13-15, 15-17 12-13, 13-18, 15-19 13-12, 14-16, 15-18, 17-19, 22-20 12-14, 13-18, 15-19 12-13, 13-19 |

RECORD — CONTINUED.

| Name of chemical used. | Strength, per cent. | No. hours soaked. | Date of putting to soak..... | Date and amount of germination of check..... | Date and amount of germination. |
|---|---------------------|-------------------|------------------------------|--|---|
| Potassium hydrate. (Caustic potash.) (Concluded.) | 1 | 5 | 5-6 | 12-20 | 12-17, 13-20 |
| | 1 | 8 | 5-6 | 12-18, 13-19 | 12-20 |
| | 1 | 16 | 5-6 | 12-20 | 12-3, 13-19 |
| | 1 | 24 | 5-6 | 12-20 | 0 |
| | 1 | 24 | 11-7 | ..... | 16-1, 17-6 |
| | 5 | 1 | 5-6 | 12-16, 13-20 | 12-1, 13-7, 15-8 |
| | 5 | 3 | 5-6 | 12-16, 13-20 | 12-3, 15-7 |
| | 5 | 5 | 5-6 | 12-20 | 15-2 |
| | 5 | 8 | 5-6 | 12-18, 13-19 | 0 |
| | 5 | 16 | 5-6 | 12-20 | 0 |
| | 10 | 1 | 5-6 | 12-16, 13-20 | 0 |
| | 10 | 3 | 5-6 | 12-16, 13-20 | 0 |
| | 10 | 5 | 5-6 | 12-20 | 0 |
| | 10 | 8 | 5-6 | 12-18, 13-19 | 0 |
| | 20 | 1 | 5-6 | 12-16, 13-20 | 0 |
| | 20 | 3 | 5-6 | 12-16, 13-20 | 0 |
| | 20 | 5 | 5-6 | 12-20 | 0 |
| 20 | 8 | 5-6 | 12-18, 13-19 | 0 | |
| Potassium iodide. | 5 | 48 | 11-21 | ..... | 1-2 |
| | 10 | 24 | 6-16 | 21-20 | 22-1, 23-18 |
| Potassium nitrate. (Saltpeter.) | 5 | 48 | 11-21 | ..... | 23-7, 30-12, 2-15 |
| | 5 | 72 | 11-7 | 14-5, 21-17 | 19-4, 30-6, 1-7 |
| | 10 | 24 | 3-7 | 16-47 | 15-8, 16-21, 17-23, 18-25 |
| | 10 | 48 | 5-21 | 23-20 | 28-20 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 15-4, 17-6 |
| | 10 | 96 | 10-10 | 13-13, 17-20 | 0 |
| Potassium nitrite. | 2½ | 24 | 11-24 | ..... | 1-1, 2-7, 3-8, 5-12, 10-13 |
| | 5 | 24 | 10-8 | 12-6, 13-18 | 14-6, 15-10, 17-12 |
| | 10 | 24 | 6-17 | 21-20 | 23-1 |
| Potassium oxalate. | 2½ | 24 | 11-24 | ..... | 2, 4, 3-6, 5-7, 10-8 |
| | 5 | 24 | 10-8 | 12-6, 13-18 | 13-1, 14-5, 15-7, 17-9, 19-10 |
| | 10 | 24 | 3-7 | 16-47 | 14-8, 15-20, 16-22 |
| | 10 | 24 | 5-12 | 16-20 | 16-17 |
| | 10 | 24 | 6-14 | 20-20 | 20-6, 22-13, 23-18 |
| Potassium permanganate. | 2½ | 24 | 11-24 | ..... | 1-20 |
| | 5 | 24 | 10-8 | 12-6, 13-18 | 13-2, 14-6, 15-10, 17-12, 22-13 |
| | 10 | 24 | 6-1 | 20-20 | 22-1 |
| Potassium sulphide. | 10 | 24 | 3-7 | 16-47 | 15-1, 16-8, 17-10, 18-13, 19-16, 20-20, 21-21 |
| | 10 | 24 | 5-17 | 25-20 | 25-20 |
| Potassium sulphocyanide. | 2½ | 24 | 11-24 | ..... | 3-8, 5-15 |
| | 5 | 24 | 10-8 | 12-6, 13-18 | 13-1, 14-6, 15-10, 17-13, 21-14 |
| | 10 | 24 | 6-16 | 21-20 | 0 |
| Potassium tartrate. | 5 | 24 | 10-8 | 12-6, 13-18 | 13-6, 14-12 |
| | 5 | 24 | 11-5 | 11-5, 14-19 | 14-10, 16-12 |
| | 10 | 24 | 6-23 | 27-20 | 27-13, 28-19 |
| | 10 | 48 | 7-18 | 22-20 | 22-12, 26-19 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 14-14, 15-18 |
| Potassium bitartrate. | 5 | 24 | 9-9 | 14-6, 16-17 | 14-3, 15-14, 16-20 |
| | 48 | 9-23 | 23-11, 30-17 | ..... | 23-13, 29-13, 30-19 |
| | 72 | 11-7 | 14-5, 21-17 | ..... | 19-1, 30-2 |
| Potassium antimonyl tartrate. (Tartar emetic.) | 3½ | 48 | 11-21 | ..... | 28-18 |
| | 7 | 24 | 5-23 | 23-20 | 28-19 |
| | 7 | 48 | 7-9 | 12-20 | 12-5, 14-6, 15-10, 16-13, 18-14, 19-15 |
| Sodium arsenate. | 1 | 1 | 7-18 | 24-16 | 24-16 |
| | 3 | 3 | 7-18 | 24-17 | 24-10, 25-11 |
| | 5 | 5 | 7-18 | 24-16 | 24-2 |
| | 8 | 8 | 7-18 | 24-3 | 24-1 |
| | 16 | 16 | 7-19 | 24-19 | 24-10 |

RECORD—CONTINUED.

| Name of chemical used. | Strength, per cent. | No. hours soaked | Date of putting to soak | Date and amount of germination of check | Date and amount of germination |
|-----------------------------------|---------------------|------------------|-------------------------|---|--------------------------------|
| Sodium arseniate. (Concluded.) | 1 | 24 | 7-19 | 24-20 | 24-2, 26-5 |
| | 1 | 1 | 7-18 | 24-16 | 24-12 |
| | 1 | 3 | 7-18 | 24-17 | 24-13 |
| | 1 | 5 | 7-18 | 24-16 | 24-6 |
| | 1 | 8 | 7-18 | 24-3 | 0 |
| | 1 | 16 | 7-19 | 24-19 | 24-3, 25-4 |
| | 1 | 24 | 11-5 | 11-5, 14-19 | 14-2, 19-3 |
| | 5 | 1 | 7-18 | 24-16 | 24-10 |
| | 5 | 3 | 7-18 | 24-17 | 24-6 |
| | 5 | 5 | 7-18 | 24-16 | 24-2 |
| | 5 | 8 | 7-18 | 24-3 | 0 |
| | 5 | 16 | 7-19 | 24-19 | 27-2 |
| | 5 | 24 | 6-21 | 28-20 | 0 |
| | 24 | 24 | 8-5 | 9-20 | 0 |
| | 10 | 1 | 7-18 | 24-16 | 24-2 |
| | 10 | 3 | 7-18 | 24-17 | 24-1 |
| | 10 | 5 | 7-18 | 24-16 | 0 |
| | 10 | 8 | 7-18 | 24-3 | 0 |
| | 10 | 24 | 5-12 | 16-20 | 18-1, 19-3, 20-5, 25-6 |
| | 10 | 24 | 3-7 | 16-17 | 17-1, 18-2, 21-4, 22-5, 24-6 |
| | 20 | 1 | 7-18 | 24-16 | 24-3 |
| | 20 | 3 | 7-18 | 24-17 | 24-1 |
| | 20 | 5 | 7-18 | 24-16 | 0 |
| | 20 | 8 | 7-18 | 24-3 | 0 |
| Sodium arsenite. | 1 | 3-16 | 21-19 | 21-18 | |
| | 3 | 3-16 | 22-20 | 21-20 | |
| | 5 | 3-16 | 21-20 | 21-19 | |
| | 8 | 3-16 | 22-19 | 21-20 | |
| | 16 | 3-15 | 21-17 | 21-15, 30-16 | |
| | 24 | 3-15 | 21-20 | 22-1, 23-4, 25-5 | |
| | 1 | 1 | 3-16 | 21-19 | 21-20 |
| | 1 | 3 | 3-16 | 22-20 | 21-19 |
| | 1 | 5 | 3-16 | 21-20 | 21-18 |
| | 1 | 8 | 3-16 | 22-19 | 21-17, 23-18, 24-19 |
| | 1 | 16 | 3-15 | 21-17 | 21-9 |
| | 1 | 24 | 3-15 | 21-20 | 22-6, 23-8, 30-10 |
| | 1 | 24 | 11-10 | 17-11, 19-17 | 17-4, 19-7, 21-13, 28-14 |
| | 24 | 24 | 11-5 | 11-5, 14-19 | 16-1, 25-3 |
| | 5 | 1 | 3-16 | 21-19 | 21-8, 22-15, 25-16 |
| | 5 | 3 | 3-16 | 22-20 | 22-11, 23-13, 24-14 |
| | 5 | 5 | 3-16 | 21-20 | 22-10, 23-12 |
| | 5 | 8 | 3-16 | 22-19 | 22-1, 23-6 |
| | 5 | 16 | 3-15 | 21-17 | 22-2, 23-7, 30-8 |
| | 5 | 24 | 3-15 | 21-20 | 25-1 |
| | 5 | 24 | 6-23 | 2-20 | 5-2 |
| | 10 | 1 | 3-16 | 21-19 | 23-7, 25-8 |
| | 10 | 3 | 3-16 | 22-20 | 22-1, 23-4 |
| | 10 | 5 | 3-16 | 21-20 | 21-1, 22-6, 23-7, 25-8, 30-10 |
| 10 | 8 | 3-16 | 22-19 | 22-1, 23-2, 24-3, 25-4, 28-5 | |
| 10 | 24 | 3-7 | 16-17 | 16-1, 17-2, 18-3, 19-9, 21-15, 23-16 | |
| 10 | 24 | 5-13 | 25-20 | 28-5, 31-6 | |
| 20 | 1 | 3-16 | 21-19 | 23-1, 24-3, 25-4 | |
| 20 | 3 | 3-16 | 22-20 | 0 | |
| 20 | 5 | 3-16 | 21-20 | 22-4, 23-7, 25-8 | |
| 20 | 8 | 3-16 | 22-19 | 22-1, 23-4, 24-5 | |
| Sodium acetate. | 10 | 24 | 3-7 | 16-17 | 15-15, 16-25 |
| | 10 | 48 | 7-7 | 11-20 | 13-20 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 14-1, 15-3, 17-10, 20-11 |
| | 10 | 96 | 11-2 | 10-3, 16-17 | 11-2, 14-4, 15-5, 19-7 |
| | | | | | |
| Sodium borate. (Borax.) | 3 | 24 | 11-10 | 17-11, 19-17 | 17-3, 19-9, 20-10, 21-11 |
| | 3 | 24 | 10-4 | 8-12, 10-20 | 15-2, 17-5 |
| | 6 | 24 | 4-4 | 8-18 | 8-14, 9-18, 11-19, 13-20 |
| | 6 | 24 | 4-4 | 8-18 | 0 |
| | 6 | 48 | 7-7 | 11-20 | 0 |
| Sodium carbonate. | 5 | 24 | 10-4 | 8-12, 10-20 | 10-6, 11-9, 12-12, 13-13 |
| | 5 | 48 | 11-21 | ..... | 23-2, 30-5, 1-9, 5-10 |
| | 10 | 24 | 4-4 | 8-18 | 8-8, 9-15, 11-17, 13-18 |

RECORD—CONTINUED.

| Name of chemical used. | Strength, per cent | No. hours soaked .. | Date of putting to soak | Date and amount of germination of check. | Date and amount of germination. |
|---|--------------------|---------------------|-------------------------------|--|---|
| Sodium bicarbonate. | 5 | 24 | 10-4 | 8-12, 10-20 | 10-14, 11-15, 12-17, 13-18, 14-20 |
| | 5 | 24 | 11-9 | ..... | 17-14, 21-15 |
| | 10 | 24 | 4-4 | 8-18 | 8-18, 11-19 |
| | 10 | 48 | 7-7 | 11-20 | 0 |
| Sodium chloride. (Common salt.) | 5 | 24 | 10-4 | 8-12, 10-20 | 8-2, 10-15, 11-17, 13-18 |
| | 5 | 48 | 11-21 | ..... | 28-15, 1-16 |
| | 10 | 24 | 4-6 | 11-19, 14-20 | 11-16, 13-19, 14-20 |
| Sodium hydrate. (Caustic soda.) | 1 | 24 | 11-5 | 11-5, 14-19 | 12-4, 14-11, 15-13, 16-15, 30-17 |
| | 1 | 1 | 5-20 | 25-20 | 25-19, 29-20 |
| | 3 | 3 | 5-20 | 25-20 | 25-20 |
| | 5 | 5 | 5-20 | 25-18, 29-20 | 25-16, 29-18 |
| | 9 | 9 | 5-20 | 25-20 | 25-18 |
| | 16 | 16 | 5-20 | 25-15, 1-20 | 25-3, 29-4 |
| | 24 | 24 | 5-27 | 2-20 | 6-3, 10-4 |
| | 1 | 1 | 5-20 | 25-20 | 25-15, 29-20 |
| | 1 | 3 | 5-20 | 25-20 | 25-12, 26-18 |
| | 1 | 5 | 5-20 | 25-18, 29-20 | 25-12, 29-13 |
| | 1 | 9 | 5-20 | 25-20 | 29-1, 30-6 |
| | 1 | 16 | 5-20 | 25-15, 1-20 | 0 |
| | 1 | 24 | 5-27 | 2-20 | 8-1 |
| | 1 | 24 | 6-28 | 2-20 | 0 |
| | 24 | 24 | 5-14 | 18-11, 19-20 | 0 |
| | 5 | 1 | 5-20 | 25-20 | 25-11, 29-13 |
| | 5 | 3 | 5-20 | 25-20 | 0 |
| | 5 | 5 | 5-20 | 25-18, 29-20 | 0 |
| | 5 | 9 | 5-20 | 25-20 | 0 |
| | 5 | 16 | 5-20 | 25-15, 1-20 | 0 |
| | 5 | 24 | 10-8 | 12-6, 13-18 | 15-1, 17-3 |
| | 10 | 1 | 5-20 | 25-20 | 0 |
| | 10 | 3 | 5-20 | 25-20 | 0 |
| | 10 | 5 | 5-20 | 25-18, 27-20 | 0 |
| 10 | 9 | 5-20 | 25-20 | 0 | |
| 20 | 1 | 5-20 | 25-20 | 0 | |
| 20 | 3 | 5-20 | 25-20 | 0 | |
| 20 | 5 | 5-20 | 25-18, 29-20 | 0 | |
| Sodium nitrate. (Chili saltpeter.) | 5 | 24 | 11-5 | 11-5, 14-19 | 12-1, 14-16 |
| | 10 | 24 | 10-4 | 8-12, 10-20 | 10-6, 11-11, 12-15 |
| | 10 | 24 | 8-29 | 3-15, 5-19 | 3-5, 5-20 |
| | 10 | 48 | 9-23 | 28-11, 30-17 | 30-1 |
| Sodium phosphate. | 10 | 24 | 4-4 | 8-18 | 8-19, 9-20 |
| | 10 | 48 | 7-7 | 11-20 | 12-17, 13-19 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 14-15, 17-18 |
| | 10 | 96 | 11-2 | 10-3, 16-17 | 7-1, 8-3, 9-9, 10-14, 11-16, 12-17, 14-18 |
| Sodium ammonium phosphate. (Microcosmic salt.) | 5 | 24 | 10-4 | 8-12, 10-20 | 10-15, 11-16, 12-17, 20-18 |
| | 5 | 24 | 11-9 | ..... | 17-14 |
| | 10 | 24 | 8-5 | 9-20 | 0 |
| Sodium silicate. | 5 | 24 | 10-4 | 8-12, 10-20 | 12-1, 13-2, 14-3 |
| Sodium sulphate. | 10 | 24 | 3-7 | 16-47 | 14-5, 15-18, 16-21, 17-22, 18-25 |
| | 10 | 24 | 3-28 | 5-20 | 6-20 |
| | 10 | 24 | 5-17 | 25-20 | 25-20 |
| | 10 | 48 | 7-9 | 12-20 | 12-20 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 13-1, 14-7, 15-17, 17-19 |
| | 10 | 96 | 11-2 | 10-3, 16-17 | 14-9, 16-13, 17-14, 18-17 |
| Sodium sulphide. | 10 | 24 | 8-29 | 3-15, 5-19 | 3-2, 5-11, 6-14, 9-15 |
| Sodium sulphite. | 5 | 24 | 10-4 | 8-12, 10-20 | 8-6, 10-17 |
| | 5 | 24 | 11-5 | 11-5, 14-19 | 12-2, 14-3, 15-6, 30-8 |
| | 10 | 48 | 7-9 | 12-20 | 12-20 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 15-3, 17-7, 22-8, 24-10 |

RECORD — CONCLUDED.

| Name of chemical used. | Strength, per cent. | No. hours soaked .. | Date of putting to soak..... .. | Date and amount of germination of check..... .. | Date and amount of germination. |
|---|---------------------|---------------------|---------------------------------|---|----------------------------------|
| Sodium thiosulphate. (Hyposulphite of soda.) | 5 | 24 | 10-4 | 8-12, 10-20 | 8-4, 10-14, 11-16, 12-19 |
| | 10 | 24 | 5-23 | 28-20 | 28-20 |
| | 10 | 48 | 7-9 | 12-20 | 12-8, 14-16, 15-18, 19-19 |
| | 10 | 96 | 10-10 | 13-13, 17-20 | 14-4, 17-5, 19-6 |
| Strontium nitrate. | 10 | 24 | 6-17 | 21-20 | 23-8, 24-17, 28-18 |
| | 10 | 48 | 7-18 | 22-20 | 26-20 |
| | 10 | 72 | 10-10 | 13-13, 15-20 | 14-7, 15-14, 17-16 |
| Sulphuric acid. | 2½ | 24 | 8-5 | 9-20 | 0 |
| | 5 | 24 | 6-27 | 30-20 | 30-1, 1-10, 2-11 |
| | 10 | 24 | 3-7 | 16-47 | 15-10, 16-16, 17-19 |
| | 10 | 24 | 5-14 | 19-20 | 19-3, 20-4, 21-7, 22-8 |
| Zinc chloride. | 10 | 24 | 3-17 | 22-6, 25-10 | 24-2, 25-6, 28-7, 2-8, 6-10 |
| | 5 | 48 | 11-21 | ..... | 30-7, 1-14, 2-15, 5-16, 6-17 |
| | 10 | 48 | 7-20 | 26-20 | 27-2 |
| Zinc sulphate. (White vitriol.) | 10 | 24 | 3-7 | 16-47 | 14-7, 15-21, 16-24, 17-25 |
| | 10 | 48 | 7-20 | 26-20 | 26-18 |
| | 10 | 72 | 11-7 | 14-5, 21-17 | 15-7, 16-10, 19-11, 21-13, 23-14 |

The following is an analysis of the above table, the chemicals being grouped as the results seem to justify. It will be observed that the vitality of the seed steadily diminishes from spring until fall, from which cause they are less able to resist the action of the chemicals during the latter period. For this reason there is occasionally apparently less germination with a solution of a certain strength than with one of greater strength. But in nearly all cases it will be seen that the weaker solution was used later in the season.

GROUP I.—GERMINATION ENTIRELY PREVENTED.

- Acetic acid, 5 per cent., 24 hours.
- Alcohol, methyl, 10 per cent., 24 hours.
- Ammonium carbonate, 10 per cent., 24 hours.
- Ammonium hydrate, 10 per cent., 24 hours.
- Ammonium sulphocyanide, 10 per cent., 24 hours.
- Ammonium ferrous sulphate, 10 per cent., 48 hours.
- Arsenous oxide, 1/5 per cent., 5, 8 and 16 hours; 2/5 per cent., 5 and 8 hours; 1 per cent., 3, 5 and 8 hours; 2 per cent., 1, 3, 5, 8 and 24 hours.
- Boric acid, 4 per cent., 24 hours; 2 per cent., 96 hours.
- Cadmium bromide, 1/20s, 24 hours; ¼s, 24 hours; ½s, 24 hours; s, 24 hours.
- Cadmium sulphate, 5 per cent., 96 hours.
- Copper acetate, half strength, 24 hours; full strength, 24 hours.
- Mercuric chloride, 1/10 per cent., 24 hours; ½ per cent., 24 hours; 1 per cent., 24 hours, 3 per cent., 1, 3, 5 and 8 hours; 6 per cent., 1, 3, 5 and 8 hours.
- Nitric acid, 5 per cent., 24 hours.
- Nickel chloride, 10 per cent., 24 hours.
- Picric acid, saturated solution, 24 hours.
- Potassium cyanide, 5 per cent., 24 hours; 10 per cent., 24 hours.

- Potassium hydrate, 5 per cent., 8 and 16 hours; 10 per cent., 1, 3, 5 and 8 hours; 20 per cent., 1, 3, 5 and 8 hours.
- Potassium nitrate, 10 per cent., 96 hours.
- Potassium sulphocyanide, 10 per cent., 24 hours.
- Sodium arseniate, 5 per cent., 8, 16 and 24 hours; 2½ per cent., 24 hours; 10 per cent., 5, 8 and 24 hours; 20 per cent., 5 and 8 hours.
- Sodium borate, 6 per cent., 48 hours.
- Sodium bicarbonate, 10 per cent., 48 hours.
- Sodium hydrate, 1 per cent., 16 and 24 hours; 2½ per cent., 24 hours; 5 per cent., 3, 5, 9, 16 and 24 hours; 10 per cent., 1, 3, 5 and 9 hours; 20 per cent., 1, 3 and 5 hours.
- Sodium ammonium phosphate, 10 per cent., 24 hours.
- Sulphuric acid, 2½ per cent., 24 hours.

GROUP II.—GERMINATION LESS THAN 50 PER CENT.

- Aluminum sulphate, 10 per cent., 72 hours.
- Ammonium chloride, 5 per cent., 48 hours; 10 per cent., 48 and 72 hours.
- Ammonium nitrate, 10 per cent., 24 and 48 hours.
- Ammonium oxalate, 10 per cent., 24 hours.
- Ammonium sulphocyanide, 5 per cent., 24 hours.
- Arsenous oxide, 1/5 per cent., 1 and 3 hours; 2/5 per cent., 3 hours; 1 per cent., 1 hour; 2 per cent., 5 hours.
- Barium chloride, 5 per cent., 72 hours.
- Cadmium bromide, ¼s, 16 hours; ½s, 16 hours; s, 8 and 16 hours.
- Cadmium sulphate, 10 per cent., 24 hours.
- Chromium potassium sulphate, 10 per cent., 96 hours.
- Cobalt nitrate, 10 per cent., 48 hours.
- Copper chloride, 5 per cent., 48 hours; 10 per cent., 48 hours.
- Copper sulphate, 5 per cent., 48 hours; 10 per cent., 72 hours.
- Lead acetate, 10 per cent., 72 hours.
- Manganese sulphate, 10 per cent., 72 hours.
- Mercuric chloride, 1/10 per cent., 16 hours; 1 per cent., 3, 5 and 8 hours.
- Nickel sulphate, 5 per cent., 48 hours; 10 per cent., 48 hours.
- Phosphoric acid, 5 per cent., 96 hours; 10 per cent., 48 hours.
- Potassium acetate, 5 per cent., 72 hours; 10 per cent., 96 hours.
- Potassium bromide, 10 per cent., 48 hours.
- Potassium chlorate, 10 per cent., 24 hours.
- Potassium chromate, 10 per cent., 24 hours.
- Potassium cyanide, 1 per cent., 5, 8, 16 and 24 hours; 5 per cent., 16 hours; 10 per cent., 5 and 8 hours; 20 per cent., 5 and 8 hours.
- Potassium ferrocyanide, 10 per cent., 24 hours.
- Potassium hydrate, 1 per cent., 24 hours; 5 per cent., 1, 3 and 5 hours.
- Potassium iodide, 5 per cent., 48 hours.
- Potassium nitrate, 5 per cent., 72 hours; 10 per cent., 72 hours.
- Potassium nitrite, 2½ per cent., 24 hours; 5 per cent., 24 hours; 10 per cent., 24 hours.
- Potassium oxalate, 2½ per cent., 24 hours.
- Potassium permanganate, 10 per cent., 24 hours.
- Potassium bitartrate, 2/5 per cent., 72 hours.
- Sodium arseniate, ½ per cent., 5, 8, 16 and 24 hours; 1 per cent., 5, 8, 16 and 24 hours; 5 per cent., 3 and 5 hours; 10 per cent., 1 and 3 hours; 20 per cent., 1 and 3 hours.

Sodium arsenite, $\frac{1}{2}$ per cent., 24 hours; 1 per cent., 16 and 24 hours; $2\frac{1}{2}$ per cent., 24 hours; 5 per cent., 8, 16 and 24 hours; 10 per cent., 1, 3, 5, 8 and 24 hours; 20 per cent., 1, 3, 5 and 8 hours.
Sodium acetate, 10 per cent., 96 hours.
Sodium borate, 3 per cent., 24 hours.
Sodium hydrate, $\frac{1}{2}$ per cent., 16 and 24 hours; 1 per cent., 9 hours.
Sodium nitrate, 10 per cent., 48 hours.
Sodium silicate, 5 per cent., 24 hours.
Sodium thiosulphate, 10 per cent., 96 hours.
Zinc sulphate, 10 per cent., 48 hours.

GROUP III.—GERMINATION FROM 50 TO 80 PER CENT.

Alcohol, common, 5 per cent., 48 hours.
Aluminum sulphate, 5 per cent., 72 hours.
Ammonium aluminum sulphate, 10 per cent., 48 hours.
Arsenous oxide, $\frac{2}{5}$ per cent., 1 hour.
Barium chloride, 10 per cent., 72 hours.
Cadmium bromide, $\frac{1}{20}$ s, 16 hours; $\frac{1}{2}$ s, 8 hours; s, 3 hours.
Calcium hydrate, 1 per cent., 48 hours.
Cobalt nitrate, 5 per cent., 24 hours.
Copper nitrate, 10 per cent., 48 hours.
Copper sulphate, 10 per cent., 24 and 48 hours.
Ferric chloride, 10 per cent., 72 hours.
Hydrochloric acid, 5 per cent., 24 hours.
Lead nitrate, 10 per cent., 72 hours.
Mercuric chloride, $\frac{1}{20}$ per cent., 24 hours.
Phosphoric acid, 10 per cent., 24 hours.
Potassium acetate, 10 per cent., 72 hours.
Potassium chlorate, 5 per cent., 24 hours.
Potassium chloride, 5 per cent., 24 hours; 10 per cent., 24 hours.
Potassium chromate, $2\frac{1}{2}$ per cent., 24 hours; 5 per cent., 24 hours.
Potassium cyanide, $\frac{1}{2}$ per cent., 3, 5, 8, 16 and 24 hours; 1 per cent., 3 hours; 5 per cent., 5 and 8 hours; 10 per cent., 3 hours; 20 per cent., 1 and 3 hours.
Potassium ferricyanide, 5 per cent., 24 hours.
Potassium nitrate, 5 per cent., 48 hours.
Potassium permanganate, 5 per cent., 24 hours.
Potassium sulphocyanide, $2\frac{1}{2}$ per cent., 24 hours; 5 per cent., 24 hours.
Potassium antimonyl tartrate, 7 per cent., 48 hours.
Sodium arseniate, $\frac{1}{2}$ per cent., 1 and 3 hours; 1 per cent., 1 and 3 hours; 5 per cent., 1 hour.
Sodium arsenite, $\frac{1}{2}$ per cent., 16 hours; 5 per cent., 1, 3 and 5 hours.
Sodium acetate, 10 per cent., 72 hours.
Sodium borate, $\frac{3}{5}$ per cent., 24 hours.
Sodium carbonate, 5 per cent., 24 and 48 hours; 10 per cent., 24 hours.
Sodium chloride, 5 per cent., 48 hours.
Sodium hydrate, 1 per cent., 5 hours; 5 per cent., 1 hour.
Sodium nitrate, 5 per cent., 24 hours; 10 per cent., 24 hours.
Sodium ammonium phosphate, 5 per cent., 24 hours.
Sodium sulphide, 10 per cent., 24 hours.
Sodium sulphite, 10 per cent., 72 hours.
Strontium nitrate, 10 per cent., 72 hours.
Sulphuric acid, 5 per cent., 24 hours; 10 per cent., 24 hours.

Zinc chloride, 10 per cent., 24 hours.

Zinc sulphate, 10 per cent., 72 hours.

GROUP IV.—GERMINATION FROM 80 TO 100 PER CENT., BUT RETARDED.

Alcohol, common, 10 per cent., 24 hours.

Aluminum sulphate, 10 per cent., 24 and 48 hours.

Aluminum ammonium sulphate, 10 per cent., 24 hours.

Aluminum potassium sulphate, 10 per cent., 72 and 96 hours.

Ammonium ferrous sulphate, 10 per cent., 24 hours.

Boric acid, 2 per cent., 24 hours.

Cadmium bromide, 1/4s, 3 and 8 hours; 1/2s, 3 hours.

Cadmium sulphate, 5 per cent., 24 hours.

Calcium chloride, 10 per cent., 24, 48 and 72 hours.

Calcium hydrate, 1/5 per cent., 48 and 72 hours.

Chromium potassium sulphate, 10 per cent., 72 hours.

Cobalt nitrate, 10 per cent., 24 hours.

Copper chloride, 10 per cent., 24 hours.

Copper nitrate, 10 per cent., 24 hours.

Ferric chloride, 10 per cent., 24 and 48 hours.

Ferrous sulphate, 10 per cent., 24, 48 and 72 hours.

Ferric potassium sulphate, 10 per cent., 24 and 48 hours.

Lead acetate, 10 per cent., 24 and 48 hours.

Lead nitrate, 10 per cent., 24 and 48 hours.

Magnesium chloride, 10 per cent., 24, 48 and 96 hours.

Magnesium sulphate, 10 per cent., 48 and 96 hours.

Mercuric chloride, 1/10 per cent., 1, 3, 5, 8 and 72 hours; 1 per cent., 1 hour.

Nitric acid, 2 per cent., 24 hours.

Nickel chloride, 5 per cent., 24 hours.

Nickel sulphate, 10 per cent., 24 hours.

Potassium bromide, 10 per cent., 24 hours.

Potassium bichromate, 5 per cent., 24 hours; 10 per cent., 24 hours.

Potassium chloride, 2½ per cent., 24 hours.

Potassium cyanide, 1 per cent., 1 hour; 5 per cent., 1 and 3 hours; 10 per cent, 1 hour.

Potassium hydrate, ½ per cent., 1, 3, 5, 8, 16 and 24 hours; 1 per cent., 1, 3, 5, 8 and 16 hours.

Potassium iodide, 10 per cent., 24 hours.

Potassium oxalate, 5 per cent., 24 hours; 10 per cent., 24 hours.

Potassium tartrate, 5 per cent., 24 hours; 10 per cent., 24, 48 and 72 hours.

Potassium bitartrate, 2/5 per cent., 24 and 48 hours.

Potassium antimonyl tartrate, 3½ per cent., 48 hours; 7 per cent., 48 hours.

Sodium arsenite, ½ per cent., 1, 3, 5 and 8 hours; 1 per cent., 1, 3, 5 and 8 hours.

Sodium borate, 10 per cent., 24 hours.

Sodium bicarbonate, 5 per cent., 24 hours; 10 per cent., 24 hours.

Sodium chloride, 5 per cent., 24 hours; 10 per cent., 24 hours.

Sodium hydrate, 1/5 per cent., 24 hours; ½ per cent., 1, 3, 5 and 9 hours; 1 per cent., 1 hour.

Sodium phosphate, 10 per cent., 24, 48, 72 and 96 hours.

Sodium sulphate, 10 per cent., 72 and 96 hours.

Sodium sulphite, 5 per cent., 24 hours; 10 per cent., 48 hours.

Sodium thiosulphate, 5 per cent., 24 hours; 10 per cent., 24 and 48 hours.

Strontium nitrate, 10 per cent., 24 and 48 hours.

Zinc chloride, 5 per cent., 48 hours.
 Zinc sulphate, 10 per cent., 24 and 48 hours.

GROUP V.—GERMINATION SCARCELY AFFECTED.

Alcohol, methyl, 5 per cent., 24 hours.
 Aluminum potassium sulphate, 10 per cent., 24 and 48 hours.
 Barium chloride, 10 per cent., 24 and 48 hours.
 Cadmium bromide, 1/20s, 3 and 8 hours.
 Calcium hydrate, 1/5 per cent., 24 hours.
 Chromium potassium sulphate, 10 per cent., 24 hours.
 Magnesium sulphate, 10 per cent., 24 hours.
 Manganese sulphate, 10 per cent., 24 and 48 hours.
 Potassium acetate, 10 per cent., 24 hours.
 Potassium cyanide, ½ per cent., 1 hour.
 Potassium nitrate, 10 per cent., 24 and 48 hours.
 Potassium permanganate, 2½ per cent., 24 hours.
 Potassium sulphide, 10 per cent., 24 hours.
 Sodium acetate, 10 per cent., 24 and 48 hours.
 Sodium sulphate, 10 per cent., 24 and 48 hours.

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- p. 290.) Sodium benzoate (.13 per cent.) hinders germination. The action of benzoic acid of like strength for eight days prevented germination. Sulphurous acid did not entirely prevent germination.
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- NESSLER, J: Einfluss der Stärke verschiedener Lösungen auf das Keimen der Samen und das Wachsen der jungen Pflanzen und über Stärke der Lösung, die bei gegebener Düngung im feuchten Boden und bei Regen entsteht. (Wochenb. landw. Ver. Grossh. Baden, 1877, p. 41; ex Just, v, p. 674.) Sodium chloride, 5/10 per cent., hindered the germination of cabbage, clover, and hemp, but did not affect wheat. The action of ammonium sulphate, sugar and ferrous sulphate was investigated also. In these experiments the young plant grew in contact with the liquid.
- NESSLER, J: Einfluss des eisenvitriols und der karbolsäure, welche dem dünges zugesetzt werden, auf das keimen der samen und wachsen der Pflanzen. (Wochenbl. landw. Ves. Grossh. Baden, 1876, p. 42; ex Just, v., p. 673.) Seeds were planted in pots containing 1,700 grams of earth, to which had been added small quantities of ferrous sulphate or carbolic acid, either with or without an equivalent of ammonia. A detrimental effect was observed when the ferrous sulphate was more than .25 gram, or the carbolic acid more than .1 gram. In a second experiment, in which the earth was kept more moist, the seeds bore the presence of 2 grams of ferrous sulphate or 5 grams carbolic acid.
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SUMMARY.

Treating the seed with chemicals is a remedy for many fungous diseases of plants. The increased use of this method of treatment necessitated experiments showing the effect produced upon the vitality of the seed treated. Corn was chosen, as it answers best to the conditions of the experiments. A definite number of seeds were soaked for a definite time in a solution of definite strength of the chemical to be tested and the percentage of germination noted. A check experiment was carried on at the same time, in which water was used in place of the chemical. Eighty-two chemicals were tested for various strengths and for various periods of time, making a total of about 400 experiments.

Some chemicals were found to affect the vitality of the seed much more than others. Among these were mercuric chloride, arsenous oxide, cadmium bromide, and potassium cyanide. Germination was entirely prevented by

soaking for 5 hours in 1/5 per cent. arsenous oxide; and for 24 hours in 1/10 per cent. mercuric chloride, or for 1 hour in 3 per cent.

On the other hand, germination was scarcely affected by soaking for 48 hours in 10 per cent. solution of several substances, such as alum, saltpeter, and sodium sulphate.

The effect upon the vitality of the seed is shown first by the germination being retarded, and then by the per cent. of germination being lowered, and finally by the entire prevention of germination. In general, the effect is proportional to the time and to the strength of the solution.

CONCLUSIONS.

The fungicidal value of many of the chemicals included in the table has not been tested, but the following conclusions may be safely drawn:

A chemical, to be of value as a fungicide, must not be used in a solution of such strength as to injure the vitality of the treated seed.

All the chemicals included in group V may be used as fungicides, if the strength and time do not exceed those given in the table. This group includes chemicals which were not injurious in strong solutions acting from 24 to 48 hours.

The chemicals included in group IV, where the germination is from 80 to 100 per cent., should be used either in weaker solutions or for a shorter period.

Group I includes chemicals which are all decidedly injurious to the seed, and could be used only in very weak solutions or for a short period. Such substances must therefore show unusual fungicidal properties to admit of their use for this purpose.

In groups II and III, those chemicals should be avoided that are injurious when used in weak solutions for a short period. Those which are injurious only in strong solutions for a long period may be safely tried when the strength or time is reduced.