EXPERIMENTS WITH FUNGICIDES.

1. Spraying to prevent oats and wheat rust, (*Puccinia graminis*, *P. rubigo-vera* and *P. coronata*).
2. A third season's experiment in treating spot disease of currants, (*Septoria ribis* and *Cercospora angulata*).
3. Experiments in treating oats with different chemicals and hot water.

SPRAYING TO PREVENT OATS AND WHEAT RUST.

BY L. H. PAMMEL.

In Bulletin No. 16* of this Experiment Station, we reported an experiment in trying to prevent wheat rust. The three common species of rust occurring on our wheat and oats in Iowa are, Covered Rust of Wheat (*Puccinia rubigo-vera*), Common Grass Rust (*Puccinia graminis*), and Crowned Rust (*Puccinia coronata*).

The covered rust of wheat and common grass rust are more or less abundant on wheat every year, but during the seasons of 1892 and 1893 these rusts were so abundant that the wheat crop was a very poor one. Oats is affected by two rusts, Common Grass Rust and Crowned Rust. During the past few years oats has been so severely affected in various parts of this State that the crop has been a very light one. Now, if rust could be prevented by the application of some fungicide the farmers of Iowa would be able to save thousands of dollars every year. Since making our experiments, Prof. Galloway has published an exhaustive paper in regard to the treatment of wheat to prevent rust with fungicides. He tried many different fungicides, and kept a very close watch of the conditions affecting rust. As the result of his work, he concludes that rust cannot be prevented by the use of fungicides. We had reached a similar conclusion in 1891. This is owing largely to the fact that fungicides do not adhere well to foli-

*BULLETIN No. 16, Iowa Agricultural Experiment Station, pp. 324-329.

age and is spread over the leaf very unevenly; again, grains are constantly growing till the flowering period has passed. While the older leaves may have an abundance of the fungicide adhering, the new leaves in the intervening period will have none, unless applications are made very frequently, even then it would be possible for some of the spores to germinate and work their way down into the interior of the tissues.

In the spring of 1893 we repeated our experiments with wheat, and also made some experiments with oats. We aimed to apply once in ten days, but owing to rains the intervening time was less than ten days on an average. They were sprayed till the flowering period. The experiments were made in two series, using Bordeaux mixture of the following formula:

Copper sulphate, finely pulverized, 6 pounds.
Dissolved in 8 gallons of water.
Water, 37 gallons.
Unslacked lime, 4 pounds.
Molasses, 10 pounds.
Ammonial carbonate of copper as follows:
Ammonia, 3 pints.
Carbonate of copper, 5 ounces.
Molasses, 10 pounds.

Treatment with wheat began in May; oats about a week later. The Bordeaux mixture with molasses spread evenly over the surface, but from the first the leaves were injured, the tips becoming brown. The first application of Bordeaux mixture on wheat was made on May 13; second, May 18; third, June 3; fourth, June 7; fifth, June 10. Rust appeared on sprayed June 12; sprayed again on June 17. Bordeaux mixture was applied to oats when two or three inches tall. Applications were made as follows: June 1, 3, 5, 7, 10 and 17. Ammoniacal carbonate of copper on oats did not injure the leaves. We always aimed to apply immediately after a rain, the rain having a tendency to wash off the fungicide. The application of this fungicide was made on the same dates, although oats were still growing we ceased to apply, on account of the abundance of rust.

The results turned out as we expected; there being no appreciable difference between sprayed and check plants. Our former conclusions are, therefore, fully substantiated, and we

must experiment along other lines. Some of these experiments are now in progress.

A THIRD SEASON'S EXPERIMENT IN TREATING SPOT DISEASES OF CURRANTS.[1]

BY L. H. PAMMEL.

We used two fungicides, Bordeaux mixture and ammoniacal carbonate of copper. We have reported on the successful treatment of currants in two of the Bulletins of the Experiment Station.

In the experiments of 1891 there was a positive gain with Bordeaux mixture and ammoniacal carbonate of copper. In 1891 the rains occurred at less frequent intervals than in 1891. In 1892 we summarized our work with Bordeaux mixture and ammoniacal carbonate of copper as follows:

"From these experiments we may conclude that in rainy seasons Bordeaux mixture is more efficacious than ammoniacal carbonate of copper, or at least in the proportions used above. After rains none of the ammoniacal solution could be seen on the leaves, yet Prof. Patrick, who tested for copper, found a very marked test for copper." Last season's experiments were made to test the efficacy of ammoniacal carbonate of copper when molasses was added to the preparation. The season proved to be a very favorable one for such a test, as we had very frequent rains during the months of May, June and part of July.

AMMONIACAL CARBONATE OF COPPER.

Copper carbonate	5 ounces.
Add water to make a thick paste.	
Ammonia	3 pints.
Water	.45 gallons.
Molasses	.10 pounds.

Applications were made as follows: June 6, 14, 17, 24, 30, July 6 and 19; making seven applications.

White and black currants were treated. Applications were made every fourteen days, modifying treatment accord-

[1] *Septoria ribis* and *Cercospora angulata*. Experiments made in 1891, BULLETIN No. 17, Currants, pp. 426 221, two plates. BULLETIN No. 20, Experiments in the Treatment of Spot Disease of the Cherry, Diseases of Currants and Potato Blight, pp. 716-718.

ing to condition of the weather, making somewhat more frequent applications during June and July. The treatment as here outlined proved very effectual with both preparations. Currants retained their leaves to the end of the season, showng few affected leaves.

This spring the treated plants look better than checks; the leaves are greener in color and the treated plants are making better growth.

From these experiments we may safely conclude that these diseases can be prevented; that the molasses did not injure the leaves as in oats. The experiment also shows that different plants behave differently with fungicides, some being more sensitive to copper compounds than others, a fact which we noted some time ago with reference to corn and beans. The fungicides in these experiments were applied by Mr. D. B. Stanton.

EXPERIMENTS IN TREATING OATS WITH DIFFERENT CHEMICALS AND HOT WATER.

BY F. C. STEWART AND L. H. PAMMEL.

The subject of the influence of chemicals and hot water on the germination of cereals has considerable scientific interest as well as a practical bearing since it has been shown that hot water and chemicals applied to the seed will prevent some of the smuts. We give here a brief account of some of the experiments made in 1892, reserving for another paper a discussion of the general principles and reference to the literature on the subject. In this experiment oats was treated, with the following substances: hot water, ammoniacal carbonate of copper, Bordeaux mixture and ferrous sulphate.

The strength of fungicides will be found in the following formulæ:

AMMONIACAL CARBONATE OF COPPER.

Commercial ammonia	1 quart.
Carbonate of copper	3 ounces.
Water	22 gallons.

BICHLORIDE OF MERCURY OR CORROSIVE SUBLIMATE.

Bichloride of mercury, 200 grams, dissolved in a liter of concentrated hydrochloric acid. Five cubic centimeters of

the above solution to one liter of water containing a small amount of acetic acid.

BORDEAUX MIXTURE.

Sulphate of copper, 6 pounds.
Slacked lime, 4 pounds.
Water, 23 gallons.

FERROUS SULPHATE OR COPPERAS.

Ferrous sulphate, 12 parts by weight.
Water, 1,000 parts by weight.

The contact of solutions with seed was two and twenty-four hours, with the exception of Bordeaux mixture, which was two hours The seed was planted on April 18th; 125 kernels to the row. On the 27th of April the germination was as follows:

	Contact 2 hours.	Contact 24 hours.
Ammoniacal carbonate of copper	0	0
Corrosive sublimate	8	0
Ferrous sulphate	63	13
Bordeaux mixture	46	
Hot water, 12 minutes, at 52-54° C	62	
Hot water sprouted before planting	113	
Check on April 27th	0	
On April 29th	83	

On May 5th the number germinated was as follows:

Ammoniacal carbonate of copper, two hours, 17.

On May 6th, 20; twenty-four hours, 0; the first seed coming up May 3d.

Bichloride of mercury, 2 hours, May 5th, 96; twenty-four hours, May 5th, 16.

Ferrous sulphate, 2 hours, May 5th, 112; twenty-four hours, May 5th, 107.

Bordeaux mixture, 2 hours, May 5th, 117; twenty-four hours, May 5th, 113.

Hot water, 12 minutes, at 52-54° C May 3, 104; May 5th, 102.

Check untreated, May 2, 116; May 5, 110.

It is instructive to note the difference in height of the plants under different treatment on May 5th and July 11th.

	May 5th.	July 11th.
Ammoniacal carbonate of copper, 2 hours	2.8 inch.	38.2 inch.
Ammoniacal carbonate of copper, 24 honrs.	0.0 inch.	0.0 inch.
Bichloride of mercury, 2 hours	2.4 inch.	42.6 inch.
Bichloride of mercury. 24 hours	0.0 inch.	37.2 inch.
Ferrous sulphate, 2 hours	3.1 inch.	42.0 inch.
Ferrous sulphate, 24 hours	2.6 inch.	40.5 inch.
Bordeaux mixture, 2 hours	3.0 inch.	45.2 inch.
Hot water 12 minutes, 52-54° C	0.0 inch.	46.0 inch.
Hot water sprouted before planting	3.2 inch.	44.6 inch.
Check untreated	2.8 inch.	44.0 inch.

This treatment shows that hot water, ferrous sulphate and Bordeaux mixture hastened germination, and that hot water and ferrous sulphate about equally. The greatest number germinated when treated with Bordeaux mixture, germinating better than check.

In regard to height on May 5th, ferrous sulphate ranks first, followed by Bordeaux mixture. In this we do not consider seed before sprouted. Hot water ranks first, so far as the average total height is concerned, followed by Bordeaux mixture and ferrous sulphate, the check being poorer than Bordeaux mixture. Ammoniacal carbonate of copper and bichloride of mercury, where contact was twenty-four hours, the plants were thinner, and hence made a larger growth when once started.

We may conclude from this that the well known fungicide, Bordeaux mixture, is not injurious to the plant, and that ferrous sulphate is not injurious, as some investigators report, after the plant obtains a start in the soil, because it counteracts the bad influences, salts of copper being absorbed. Bichloride of mercury and ammoniacal carbonate of copper act injuriously, the latter, when immersed for two hours, injures germination. Hot water favors and hastens the development of the plant.