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NOVEMBER, 1899.

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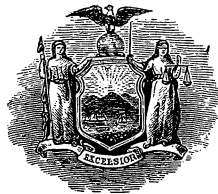
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TREATMENT FOR GOOSEBERRY MILDEW.

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C. P. CLOSE.

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C. P. CLOSE.

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**SUMMARY.**

For three seasons, Bordeaux mixture, lysol and formalin have been compared with potassium sulphide, the latter giving the best results in all three series.

The Bordeaux mixture proved comparatively valueless, as in but one series of tests did treated bushes show less mildew than check bushes; formalin in the strongest solution, 1 oz. to 1 gal. water, gave fair results, but weaker solutions ranked with the Bordeaux mixture; lysol gave promising results, coming next to the potassium sulphide in reduction of mildew injury.

With one exception, Bordeaux mixture, very early spraying gave better results than medium early or late treatments.

Winter treatment was tested during one season, but did not give sufficiently favorable results to justify recommendation.

## INTRODUCTION.

The gooseberry mildew generally makes its appearance during the last half of May or first half of June. It is first noticed as glistening, frost-like spots on the fruit on the lower part of the bush where there is usually dense shade. As the disease progresses the spots enlarge, turn dark brown and form a felt like covering over a part, or all, of the berry. In a slight attack the disease may not injure the fruit at all, or only slightly deform it. In a bad attack the fruit has a repulsive appearance, is stunted in development, and may be more or less decayed.

Two or three weeks after the mildew attacks the fruit it appears on the young, tender twigs, especially on their tips. If the attack is severe the new growth will be destroyed and the older growth will be considerably injured. In case of a very severe attack the fruit will be rendered worthless, and the foliage will be nearly, or entirely, killed during July. As a result no fruit buds are set for the next year's crop, and the bushes are so badly weakened that they may suffer from winter injury. In a few commercial plantations where little or no spraying has been done the writer has seen the crop of fruit destroyed and the bushes practically ruined by this disease. In other plantations where spraying was carefully done the greater part of the crop was saved, the foliage remained in good condition and fruit buds were set for a succeeding crop. The extent to which mildew can be prevented by spraying depends upon weather conditions and location. In a wet season like that of 1898 it flourishes abundantly and is difficult to control. The disease, as already stated, usually obtains a foothold on the lower parts of the bushes where the shade is dense. These parts are very difficult to reach thoroughly with spray solutions, and in a year when the other conditions favor the spread of the fungus, are liable to harbor more or less of the disease unless the greatest care and thoroughness are used in spraying. In a dry

season like the present one mildew can be almost entirely prevented by thorough use of fungicides. On uneven ground the higher parts of a plantation seem to be less subject to the disease than the lower parts. The best location seems to be one well elevated, with a gradual slope affording good air drainage.

In view of the destructive character of gooseberry mildew and its economic importance in all parts of America where gooseberries are grown, either for home use or for market, it was decided to undertake experiments in treating the disease on a commercial scale. The object of the experiments was to compare the potassium sulphide treatment with treatments with other fungicides and at the same time to compare very early treatments with later treatments and thus learn at what periods spraying should be done to accomplish the best results.

These investigations were begun in 1897 and have been continued for three seasons. Two commercial plantations have been under experiment. One belonging to King & Robinson is located at Trumansburg on the slopes just west of Cayuga Lake. This was treated three seasons. The other belonging to the Van Dusen Nursery Co, Geneva, and located on the upland about two miles west of Seneca Lake, was treated in 1899 only. A preliminary report giving the results of the work in 1897 may be found in Bulletin 133. A complete report of the investigations for the entire period from 1897 to 1899 is now presented for the first time.

## TRUMANSBURG EXPERIMENTS.

## PLAN.

The plantation at Trumansburg consists of 32 rows with 11 plants to the row. As shown in the diagram opposite it was divided into six plats. Each treatment was given to two plats located in different parts of the plantation. This arrangement was for the purpose of equalizing for each remedy the differences in soil and location which might exist in different parts of the plantation.

For convenience in comparing the effects of very early with medium and late spraying, three series of treatments were made. Series I was begun very early just as the buds were breaking and successive applications were made at intervals of about ten days until seven had been given. Series II was begun when the second spraying of Series I was made. Series III was begun when Series I received its third spraying and Series II its second spraying. During the remainder of the season the dates of treatment were the same for all three series. An untreated row was left as a check for each series.

## FUNGICIDES USED.

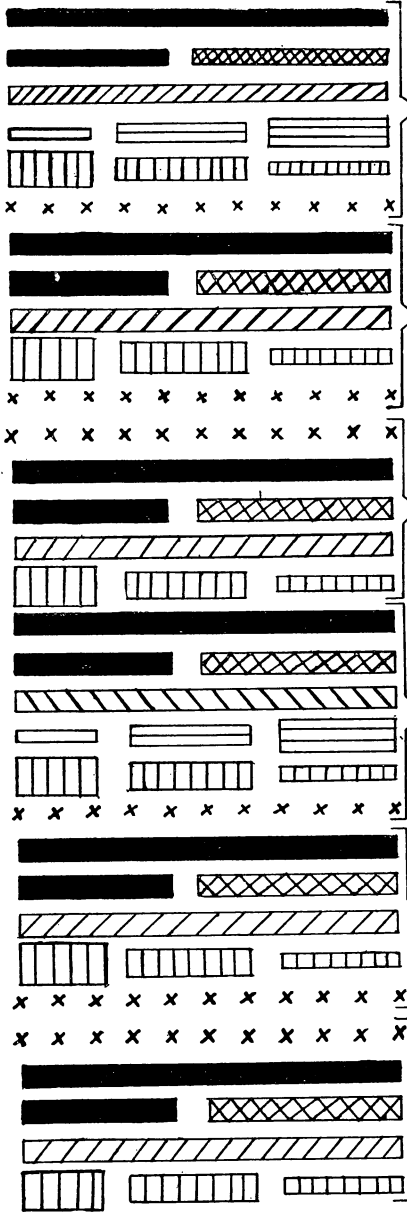
Bordeaux mixture (ordinary), 1 to 11 formula, was used until the last two or three sprayings when potassium sulphide, 1 oz. to 2 gallons water, was substituted for it. This substitution was made so that the fruit would not be spotted with Bordeaux mixture at the time it was picked for market.

Lysol and formalin were each used in three strengths, 1 oz. to 1 gal. water, 1 oz. to 2 gals. and 1 oz. to 4 gals.; and potassium sulphide in two strengths, 1 oz. to 2 gals. and 1 oz. to 3 gals. water.

Applications of these materials were made with a bucket force pump fitted with a Bordeaux nozzle. No injury was done to the foliage by any of the solutions.

## OBSERVATIONS AND DATES OF TREATMENTS.

*Tests in 1897.*—The first spraying was made April 12 just as the buds were bursting. This was followed by applications April 23, May 5, 17, 26, June 7 and 21. The bushes made a good

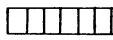


Explanation of Diagram.

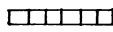
Series I.



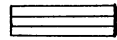
Formalin 1oz. to 1gal. water.



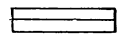
Formalin 1oz. to 2gals. water.



Series II.



Lysol 1oz. to 4gals. water.

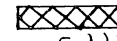


Lysol 1oz. to 2gals. water.

Series III.



Potassium Sulphide. 1oz. to 2gals. water.



Potassium Sulphide. 1oz. to 3gals. water.



Bordeaux mixture.

x x x x  
Untreated Rows.

growth and had a good setting of fruit. Mildew was found in small amounts on the fruit May 26. This developed rapidly on the fruit and by June 7 had spread to the new growth. A careful examination revealed less mildew on the bushes treated with potassium sulphide than on the other treated or untreated bushes.

As it was desired to market the fruit green, the last spraying was made June 21 and the fruit was picked early in July.

*Tests in 1898.*—Owing to the very mild weather early in March the buds began to open and by the middle of the month were in condition for the first spraying. They were not sprayed, however, because it seemed that cold weather must come and check the premature growth, hence it would be useless to spray until continuous growth might be expected. Contrary to expectation the latter part of March was not unfavorable to a slow growth and by April 1 when the first spraying was made the growth was about ten days in advance of what is desirable at the time of first application. Later applications were made April 14, 26, May 9, 21, June 1 and June 13. There was an abundance of moisture during the season which seemed to favor a rapid growth of mildew. The disease was first noticed May 25. It was quite generally distributed throughout the plantation but was most abundant on the untreated rows. The fruit was marketed green the latter part of June.

*Tests in 1899.*—The weather was unfavorable to early growth so the first spraying was not made until April 15. Later sprayings were made April 25, May 5, 15, 25, June 6 and 12.

The season was dry and the attack of mildew was comparatively light, although the bushes made an excellent growth and set a fair crop of fruit. Mildew appeared early in June and was especially noticeable on the check rows and on the under side of bushes sprayed with Bordeaux mixture. The young growth was exempt from the disease. The fruit was picked the last of June.

#### RESULTS.

Table I shows the different strengths of the various fungicides used and the percentage of mildew for the three years in each series and each treatment in the series.





PLATE I. CROWN BOB GOOSEBERRY AFFECTED BY MILDEW. A PERFECT BERRY IN LOWER RIGHT HAND CORNER.



PLATE II. STAGES AT WHICH SPRAYING SHOULD BE GIVEN FOR MILDEW.

TABLE I.—PERCENTAGE OF MILDEWED FRUIT FOR THREE SEASONS.

Fungicide.	Series I. Spraying begun very early. Seven applica- tions.			Series II. Spraying begun medium early. Six applica- tions.			Series III. Spraying begun late. Five applica- tions.		
	1897	1898	1899	1897	1898	1899	1897	1898	1899
*Bordeaux mixture: 1 to 11 formula.....	37.4	66.7	60.6	29.1	80.9	53.2	58	90.5	63
Potassium sulphide:									
1 oz. to 2 gals. water	6.6	29.3	5.5	12.3	42.7	3.5	11.5	37.9	15.1
1 oz. to 3 gals. water	5	50.9	6.6	15.1	69.5	7.5	13	66.3	6.6
Formalin:									
1 oz. to 1 gal. water.	48.8	59.9	8.9	78.3	80.9	11.2	56	63.4	8.8
1 oz. to 2 gals. water	59.1	84	15	84.7	91.9	14.9	71.4	96.8	37.5
1 oz. to 4 gals. water	52.6	95.1	16.1	65	86.7	16.2	70.4	89.1	41.9
Checks.....	57.7	80.8	22.6	78.7	98	28.5	78.7	95.7	30.6
Lysol:									
1 oz. to 1 gal. water.	24.5	74.2	6.6						
1 oz. to 2 gals. water	56.8	81.6	8.2						
1 oz. to 4 gals. water	37.1	65.1	10.9						

\* Last three treatments in each series in 1897 and last two treatments in each series in 1898 and 1899, potassium sulphide 1 oz. to 2 gals. water.

Table II shows the average percentage of mildew for each series and treatment for three seasons.

TABLE II.—AVERAGE PERCENTAGES OF MILDEWED FRUIT FOR THREE SEASONS.

Fungicide.	Series I.	Series II.	Series III.
Bordeaux .....	54.9	54.4	70.5
Potassium sulphide:			
1-2.....	13.8	19.5	21.5
1-3.....	20.8	30.7	28.6
Formalin:			
1-1.....	39.2	56.8	42.7
1-2.....	52.7	63.8	68.6
1-4.....	54.6	55.9	67.1
Checks .....	53.7	68.4	68.3
Lysol:			
1-1.....	35.1		
1-2.....	48.9		
1-4.....	37.7		

A comparison of the averages in Table II shows that potassium sulphide treatment, 1 oz. to 2 gals. water, gave the best results in all three series, the best result being in Series I where spraying was begun very early. This shows 40 per ct. less mildew than the check rows do. A weaker solution of the same material gave the next best results and here again the very early treatment of Series I is most favorable, being 23 per ct. better than untreated.

The results with lysol are promising, the strongest solution, 1 oz. to 1 gal. water, reducing the amount of mildew 18 per ct. With formalin, the treatment in Series I, using 1 oz. to 1 gal. water, was much the best, reducing the amount of mildew 14 per ct. In most other cases the tests with formalin rank with the results obtained from the use of Bordeaux mixture, which in Series II only is better than the untreated rows. In Series I and Series III the tests with Bordeaux mixture actually show a larger percentage of mildew than do the check rows. With the exception of Bordeaux mixture in Series II the very early treatments of Series I gave the best results with all tests.

The cost of the material for the remedy giving the best results, potassium sulphide, 1 oz. to 2 gals. water, is about three tenths of 1 cent per bush for seven applications per season.

## GENEVA EXPERIMENTS.

### PLAN.

The tests were carried on in the Industry plantation of the Van Dusen Nursery Co., near Geneva. During the past few seasons the attacks of mildew here were so severe that the crops were destroyed and many bushes had been either killed outright or so badly weakened that they were winter killed. The part of the plantation used for this work contained 28 rows, 20 bushes to the row.

The general plan of the work in this plantation was much like that for the work done at Trumansburg. The principal new feature was "winter spraying" with several fungicides. This was for the purpose of determining whether or not it would prove practical to spray with strong solutions while the bushes are

dormant. The object was to compare the results obtained from bushes given the winter treatment and sprayed throughout the season, with results from bushes where spraying was begun early, medium early and late; also to compare soda-Bordeaux and copper carbonate solutions with potassium sulphide as a preventive of the disease.

#### WINTER TREATMENT.

The severe weather of winter and early spring prevented the application of this treatment until April 5, but as the buds remained perfectly dormant all that time this date was satisfactory for the test. Each one of the following solutions was applied to a separate row of bushes :

Copper sulphate, 1 oz. to 1 gal. water.

Potassium sulphide, 1 oz. to 1 gal. water.

Iron sulphate, saturated solution, 5 pounds to 1 gal. water, plus 1 per cent of sulphuric acid.

\*Soda-Bordeaux mixture—1 pound copper sulphate,  $\frac{1}{3}$  pound lye, to 5 gals. water.

Copper carbonate 1 oz., ammonia to dissolve it, 5 gals. water.

Copper carbonate 3.2 oz., sodium carbonate 1.6 oz., ammonia to dissolve them, 5 gals. water.

For the remainder of the season these rows were all sprayed with potassium sulphide 1 oz. to 2 gals. water, six applications being given.

#### SUMMER TREATMENT.

This part of the work was divided into three series as was the work at Trumansburg. In Series I the work was begun very early, April 18; in Series II medium early, April 28; and in Series III late, May 9. Later applications were made May 23, June 5 and 15.

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\*A modification of Dr. Halsted's formula as given in 19th Report New Jersey Exp't Station, p. 336.

The various solutions used were :—

Potassium sulphide, 1 oz. to 2 gals. water.

\*Soda-Bordeaux,—†soda (lye) 1 pound.

Copper sulphate 3 pounds.

Lime 5 oz.

Water 30 gals.

‡Copper carbonate 1 pound, sodium carbonate (sal soda)  $\frac{1}{2}$  pound, enough strong ammonia to dissolve the copper carbonate, 50 gals. water.

Ammoniacal solution of copper carbonate,—copper carbonate 5 oz., ammonia 3 pints, water 50 gals.

Each of these solutions was applied to a separate row in Series I, II, and III.

The season was not favorable for the growth of mildew, a small amount appearing on the fruit but none on the new growth. A very little of the disease was noticed June 15. The bushes made a good growth considering the weakened condition they were in in the spring owing to previous serious attacks of the disease.

In all tests a check row was left for comparison. In Series I there was one row of each treatment and one check row set aside for the purpose of clipping off the mildewed tips as they appeared. The object was to determine whether or not it would pay to do this extra labor in a commercial plantation. It was necessary to drop this part of the experiment because no mildew appeared on the tips. A fair crop of fruit was marketed green the latter part of June.

#### RESULTS.

Table III shows the percentages of mildew from the various tests. Series IV is the part which received winter treatment.

\* Halsted B. D. 19th Report N. J. Exp't Station, p. 336.

† "Babbitt's Potash or Lye" was used.

‡ This remedy was recommended by Mr. David Allerton and Mr. J. A. Hepworth of Marlboro, N. Y., who have used it successfully against mildew on American varieties, principally Houghton. There seems to be no reason from a chemical standpoint why sodium carbonate should be used.

TABLE III.—PERCENTAGE OF MILDEWED FRUIT IN GENEVA EXPERIMENT.

Fungicides.	Series I. Spraying begun very early. Six applica- tions.	Series II. Spraying begun me- dium early. Five applica- tions.	Series III. Spraying begun late. Four applica- tions.	Series IV. Winter spraying and six applica- tions of potassium sulphide, 1 oz. to 2 gals. water.
Soda Bordeaux—1 to 10 for- mula.....	1.3	.9	2.2	—
Ammoniacal solution of copper carbonate.....	2.3	1.2	3.2	—
Strong ammoniacal solu- tion of copper carbonate plus sodium-carbonate...	1.3	1.5	1.8	—
Potassium sulphide 1 oz. to 2 gals. water.....	3.5	1.8	3	—
Checks.....	7.8	3.4	5.9	—
Copper sulphate 1 oz. to 1 gal.....	—	—	—	3.9
Iron sulphate, saturated so- lution, plus 1 per cent sul- phuric acid.....	—	—	—	2.3
Soda Bordeaux—1 to 5 for- formula.....	—	—	—	2.6
Ammoniacal solution of copper carbonate 1 oz. to 5 gals. water.....	—	—	—	1.4
Ammoniacal solution of copper carbonate 1 pound to 25 gals. water, plus so- dium carbonate ½ pound.	—	—	—	2
Potassium sulphide 1 oz. to 1 gal. water.....	—	—	—	2.9
Copper sulphate 1 oz. to 1 gal.—check row with win- ter treatment only.....	—	—	—	9.3
Check.....	—	—	—	16.5

In nearly every test this table shows very small percentages of mildew. With the winter treatment the ammoniacal solution of copper carbonate gave the best results, 1.4 per ct. of mildewed fruit where the check row had 16.5 per ct. The other winter treatments ranged from 2 per ct. to 4 per ct. The row which received the winter treatment only, 1 oz. copper sulphate to 1 gal. water, had 9.3 per ct. of mildewed fruit. This was

7.2 per ct. less mildewed fruit than its untreated row yielded but was considerably higher than the percentages of the other check rows.

The percentages of the tests in the first three series are particularly low, varying from .9 per ct. to 3.5 per ct. and the checks from 3.4 per ct. to 7.8 per ct. The very best was soda-Bordeaux in Series II, .9 per ct., the next lowest was ammoniacal solution of copper carbonate in Series II with 1.2 per cent. The tests with potassium sulphide gave the highest percentages in Series I and II and second highest in Series III. The results with strong ammoniacal solution of copper carbonate were very favorable, being from 1.3 per ct. to 1.8 per ct.

In the results for this one year there was no gain derived from the winter treatment. The soda-Bordeaux and copper carbonate solutions gave slightly better results than potassium sulphide did but these differences are not great enough to be of any significance.

#### RECOMMENDATION.

In Bulletin 133 potassium sulphide, 1 oz. to 2 or 3 gals. water, was recommended as the best remedy. The results of three years show that it is still the best fungicide the Station has thoroughly tested. Spraying should be begun very early just as the buds are breaking and continued at intervals of about ten days.

Further testing will be necessary to determine the relative merits of soda-Bordeaux mixture and the copper carbonate solutions in comparison with potassium sulphide solutions for checking gooseberry mildew.