

SPRAYING FOR GRAPE ROT.  
THE RELATION OF GRAPE SPRAYING  
TO PUBLIC HEALTH.

OHIO  
Agricultural Experiment  
Station.

WOOSTER, OHIO, U. S. A., JANUARY, 1902.

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SPRAYING FOR GRAPE ROT.

BY A. D. SELBY AND JNO. F. HICKS.

The results of the co-operative spraying experiments at Geneva, O., in 1900, and the serious problems involved in the grape rot question for Ohio vineyardists, were stated in Bulletin 123. The progress toward a demonstrated and satisfactory method of rot prevention with grapes in 1900, was not adequate to the needs of the occasion. It was found too that the small vineyard, on gravelly soil, in which the experiments of the year were carried on, was not well adapted to the work. In the plans for 1901 the possible phases of the question were duly considered and the invitation of the owners of Highland Farm, Unionville, Ashtabula county, Ohio, to conduct the experiments in the 80 acres of vineyards on that farm, was duly accepted. The plan adopted was a co-operative one and the immediate conduct of the work was placed in the hands of the Assistant Botanist, Mr. Jno. F. Hicks.

It will be recalled that about fifty per cent. of the grape crop, actually about one-fourth a crop, was saved by the spraying experiments at Geneva in 1900; about one-third of the possible crop of the Highland Farm vineyards was saved by the somewhat imperfect spraying done there the same season.

The experiments were located in the West Vineyard, containing about twelve acres. The vines are chiefly of the Concord variety, in the prime of vigorous bearing and with a uniformly good stand. The soil here is sufficiently productive to induce luxuriant growth, while the rot of previous seasons, though less destructive in this vineyard than in some others, had left the vines in condition to set and mature an enormous crop, as the returns will show. All the other vineyards on Highland Farm were under treatment by the lessees, but an unsprayed vineyard of several acres was situated about 100 yards to the westward of the vineyard under experiment.

The vineyard was properly pruned and tied, well cultivated, and twice during the summer pruned to remove the surplus leaves which might obstruct the spray and prevent the proper covering of the clusters with the fungicide.

#### SPRAY MIXTURES EMPLOYED AND APPLICATIONS MADE.

The spray mixtures employed were, as in 1900, with the addition of Soda Bordeaux mixture. These were, therefore, Bordeaux mixture made, according to the formula of the spray calendar, of 4 pounds of sulfate of copper and 4 pounds of quicklime to 50 gallons of water (the seventy-five gallon formula); ammoniacal copper carbonate, also made according to the calendar by using 6 ounces of dry copper carbonate, enough aqua ammonia to dissolve it (about 3 pints) in 50 gallons of water; also Soda Bordeaux mixture, which is a spray mixture essentially similar to the ordinary Bordeaux mixture, save that in the Soda Bordeaux, commercial caustic soda or soda lye was used to slight excess—we used in fact, of the strength employed by us, 1 pound 7 ounces of the sodium hydroxide, or caustic soda, to 4 pounds of copper sulfate in 50 gallons of mixture. In both this and the standard Bordeaux (which we shall call simply Bordeaux mixture) the copper compound is changed to the form called copper hydroxide, but with the lime it adheres longer on leaves and fruit than when prepared with the caustic soda.

On all sprayed vines the Bordeaux mixture was used for the four earlier applications, followed on certain parts with three applications of the ammoniacal copper carbonate, and on another portion, the three later applications were with the Soda Bordeaux mixture.

As indicated, seven applications, or sprayings were made as the standard, with the omissions of certain sprayings upon certain rows of the vineyard, and with an extra or early application on four other rows.

The dates of these applications are May 10, May 30, July 3, July 10, July 20, July 27, August 3 and August 12. That of May 30 just preceded blossoming; that of July 3 just followed blossoming; the other sprayings, especially, were aimed to be made at weekly intervals since they come during the period of rot prevalence.

The summary, page 31, will show the plan of the experiments.

#### SPRAYER EMPLOYED—AMOUNT OF MIXTURE USED.

The work of spraying was done by using a traction sprayer made at Geneva, O., drawn by two horses, and with double Vermorel nozzles upon rods at the ends of long lines of hose, for applying the spray. Two lines of hose were employed and a man on each line directed the spray, all the while moving slowly forward. The course of the work was hindered by the frequent breakdown of the spray machines; otherwise these served the purpose well. The

crew to each outfit, therefore, consisted of two men and team and covered about five to six acres per day. The table on page 32 will show the several facts as to rate of spraying and amounts of mixtures used in the various sprayings.

SUMMARY OF SPRAYING ON EXPERIMENT ROWS, 1901.

(Beginning at west side.)

A. Unsprayed and sprayed with Bordeaux mixture and ammoniacal copper carbonate.

- Row 1    Unsprayed.
- Row 2\*   Sprayed seven times.
- Row 3\*   Sprayed six times. Omitted first spraying.
- Row 4\*   Sprayed seven times.
- Row 5\*   Sprayed seven times.
- Row 6\*   Sprayed seven times.
- Row 7\*   Sprayed six times. Omitted second spraying.
- Row 8\*   Sprayed seven times.
- Row 9\*   Sprayed four times. Omitted last three sprayings.
- Row 10\*   Sprayed seven times.
- Row 11\*   Sprayed seven times.
- Row 12\*   Sprayed six times. Omitted third spraying.
- Row 13    Sprayed seven times.
- Row 14    Sprayed six times. Omitted seventh spraying.
- Row 15    Sprayed seven times.
- Row 16    Sprayed six times. Omitted sixth spraying.
- Row 17    Sprayed seven times.
- Row 18    Sprayed seven times.
- Row 19    Sprayed six times. Omitted fourth spraying.
- Row 20    Sprayed seven times.

B. Sprayed with Bordeaux and Soda Bordeaux mixtures.

- Row 21    Sprayed seven times.
- Row 22    Sprayed four times. Omitted last three sprayings.
- Row 23    Sprayed seven times.
- Row 24    Sprayed six times. Omitted sixth spraying.
- Row 25\*   Sprayed seven times.
- Row 26\*   Sprayed six times. Omitted seventh spraying.
- Row 27\*   Sprayed seven times.

C. Sprayed with Bordeaux and ammoniacal copper carbonate.

- Row 40    Sprayed eight times
  - Row 41    Sprayed eight times
  - Row 42    Sprayed eight times
  - Row 43    Sprayed eight times
- } An early spraying with Bordeaux, May 10.

DATES OF SPRAYING WITH KINDS OF MATERIAL.

- Extra—May 10—Bordeaux mixture.
- First—May 30—Bordeaux mixture.
- Second—July 3—Bordeaux mixture.
- Third—July 10—Bordeaux mixture.
- Fourth—July 20—Bordeaux mixture.
- Fifth—July 27—Ammoniacal copper carbonate or Soda Bordeaux.
- Sixth—August 3—Ammoniacal copper carbonate or Soda Bordeaux.
- Seventh—August 12—Ammoniacal copper carbonate or Soda Bordeaux.

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\*Gone over twice at first, second and third sprayings.

## COST OF SPRAYING.

The cost of such spraying as is ordinarily required, may be calculated from that of the fourth and subsequent sprayings of the table; in sprayings one to three, inclusive, a large section of the sprayed area was twice gone over with the spray, thus increasing the cost of labor and material. To spray 7.05 acres required ten hours of crew and 725 gallons of Bordeaux mixture. The cost would then be as follows:

## COST OF VINEYARD SPRAYING PER ACRE.

Time for crew, 1 hour per acre, 7 sprayings, 7 hours, 45 cents per hour...	\$3.15
Bordeaux mixture, 8 barrels, 4 sprayings at 25 cents per barrel.....	2.00
Ammoniacal copper carbonate or Soda Bordeaux, 7 barrels, 3 sprayings at 25 cents per barrel.....	1.95
Total.....	\$7.10

This cost per acre is about the same for materials as that given in Bulletin 123; the labor cost per acre has been reduced more than half. As to the cost of treatment for grape rot per acre it is certainly by no means prohibitive when a yield of 600 baskets or more per acre may be obtained thereby against the meager returns from unsprayed vineyards in the Unionville district the present season.

SUMMARY OF TIME AND MATERIAL CONSUMED ON AREA SPRAYED WITH BORDEAUX MIXTURE, COPPER CARBONATE AND SODA BORDEAUX; ALSO STATEMENT OF TIME AND AMOUNTS PER ACRE SPRAYED WITH SAME.

Spraying and date	Total area sprayed acres	Hours for crew	Tanks of mixture each 100 gallons	Pounds copper sulfate or copper carbonate	Acres sprayed per hour	Tanks of mixture 100 gallons each per acre
First, May 30, 1901.....	7 05	15	10¾	86	.47	1 5
Second, July 3, 1901 . . .	7 05	15	10¾	86	.47	1 5
Third, July 10, 1901. . .	7 05	15	10¾	84	.47	1 4
Fourth, July 20, 1901 ..	7 05	10	7¾	58	.70	1.02
Fifth, July 27, 1901 ....	6 34	8	8	16 & 4½*	.85	1 2
Sixth, August 3, 1901. . .	6 34	8	8¾	18 & 4½*	.79	1 3
Seventh, August 12, 1901	6 34	8	8	16 & 4½*	.79	1 3

\*Pounds of copper carbonate.

## RESULTS OF THE SPRAYING EXPERIMENTS IN 1901.

As will appear below, the results of the experiments which have just been described were very satisfactory. The area of 7.305 acres sprayed under experiment yielded 9,150 baskets, 8 pounds each, of fine grapes, or an average of 1,252.1 baskets, or 10,017 pounds per acre, certainly a large yield. The unsprayed

area alongside, .2507 acres gave no first quality grapes because so badly rotted ; it yielded 99 baskets, 8 pounds each, or 792 pounds of poor wine grapes, or 3,090 pounds per acre.

The return from the unsprayed area was \$1.50, or \$5.90 per acre, but should have brought possibly twice this amount, say \$12.00 per acre.

The average selling price of the other grapes, including baskets, was about 10 cents per basket; the average return accordingly was \$125.21 per acre. This enormously increased return was secured here at a cost of \$7.50 per acre. It is not expected that vineyards maturing a crop each year will produce such large yields regularly, but we have stated the actual results. Upon the entire vineyard area of Highland Farm, about 80 acres estimated, including those under experiment, the yield was about 53,000 baskets, or 700 baskets per acre; aside from the portion under experiment the yield was about 600 baskets per acre. This is to be attributed to imperfect treatment and on a portion to other less favorable vineyard conditions. Another point may be a discrepancy between estimated and actual areas; the areas under experiment were measured and the yield carefully recorded.

The following table gives the yield for each vineyard row, and the yield per acre of the sprayed and unsprayed portions of that part of the vineyard under experiment.

**YIELD OF GRAPES FROM ROWS UNDER EXPERIMENT, 1901.**

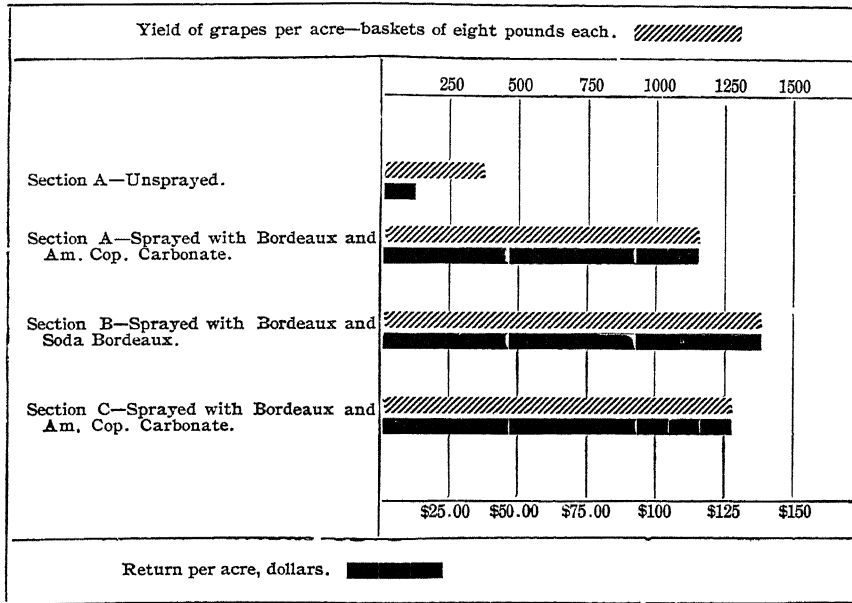
Row	Wine grapes sold, pounds	Baskets, 8 pounds each, marketable grapes	Standard rows, baskets	Other rows, baskets	Remarks
<b>Section A—Unsprayed and sprayed with Bordeaux mixture and ammoniacal copper carbonate.</b>					
1	792				Unsprayed.
2		315	315		Standard.
3		285		285	Spray omitted just before blossoming.
4		249	249		Standard.
5		321	321		Standard.
6		297	297		Standard.
7		262		262	Spray omitted just after blossoming.
8		300	300		Standard.
9		280		280	Sprayed four times Bordeaux, no copper carbonate.
10		307	307		Standard.
11		338	338		Standard.
12		322		322	Third spraying omitted.
13		322	322		Standard.
14		320		320	Last (7th) spraying omitted.
15		233	233		Standard.
16		294		294	Sixth spraying omitted.
17		365	365		Standard.
18		311	311		Standard.
19		289		289	Fourth spraying omitted.
20		305	305		Standard.
	Total yield, baskets.....	5713	3663	2052	Total area 4.76 acres; Standard 3.008 acres.
	Average per acre, baskets....	1200.6	1217.7	1172.5	
<b>Section B—Sprayed with Bordeaux mixture and Soda Bordeaux mixture.</b>					
21		295	295		Standard.
22		310*			Sprayed four times; no Soda Bordeaux.
23		321	321		Standard.
24		361		361	Soda Bordeaux twice; sixth spraying omitted.
25		322	322		Standard.
26		364		364	Soda Bordeaux twice; seventh spraying omitted.
27		304	304		Standard.
	Total yield, baskets.....	2277	1242	725	Soda Bordeaux area 1.39 acres; Standard .925 acres.
	Average per acre, baskets....	1415.1	1342.7	1516.8	
<b>Section C—Sprayed with Bordeaux mixture and ammoniacal copper carbonate.</b>					
40		298	298		Standard } " } Each row sprayed once early, May 10. " }
41		280	280		
42		297	297		
43		285	285		
	Total yield, baskets.....	1160	1160		Total area .925 acres.
	Average per acre, baskets....	1254	1254		
	All average per acre.....	1252.1	1248.4	1251.5	

\*Omitted from average of Section B.



These results are diagrammatically shown below. It will be observed that in the matter of selling price of the grapes per acre of vineyard, the unsprayed area is at even greater disadvantage than in the gross yield of grapes.

DIAGRAM SHOWING THE RESULTS OF SPRAY TREATMENT, AVERAGE YIELD OF GRAPES PER ACRE AND GROSS RETURNS PER ACRE IN 1901.



It is well to bear in mind in studying the several tables, that it is only when we are able to average the yield from several rows that sources of variation are eliminated. The uneven filling of the baskets by the different pickers is a source of possible error. While every effort was made to secure uniform results in this respect, it is too much to expect that the results were uniform with the large number of pickers, some thirty-seven in all, who participated in gathering the fruit.

COMPARISON OF AMMONIACAL COPPER CARBONATE AND SODA BORDEAUX MIXTURE.

The results in this respect are suggestive at least. While it is true that the yield of the vineyard increases towards the east, yet whether we compare the portion sprayed late with copper carbonate and next adjacent to that treated on the same dates with Soda Bordeaux mixture, rows 13 to 20, or whether we take rows 40 to 43, much farther to the east, the average of the six rows, Nos. 21, 23, 24, 25, 26 and 27, which received applications of the Soda Bordeaux mixture, is in excess of those sprayed with ammoniacal copper car-

bonate. Rows 24 and 26, which received one less spraying each of the Soda Bordeaux mixture are the highest of all, but this may arise from the error in filling the baskets, or from unevenness otherwise. Likewise rows 40 to 43 received an early spraying, which the others did not; it was the original plan to have only two of these to receive the early spraying. Yet, withal, the average of the entire area receiving Soda Bordeaux, more than one and one-third acres, is 1,415 baskets per acre against 1,217.7 and 1,254 baskets respectively on the standard sprayed areas, with ammoniacal copper carbonate for the last three sprayings. This is an apparent gain of about 180 baskets per acre, or an apparent increased return of \$18.00 per acre by using the Soda Bordeaux mixture over the the ammoniacal copper carbonate. It is too soon to assert that this apparent advantage will accrue each season; further work is needed for final determination. It is not too soon to begin to consider the general use of the Soda Bordeaux mixture for the latest sprayings for grape rots. To this end directions for preparing it are given at the end of the bulletin.

The field notes of Mr. Hicks do not show that there was an observable difference in the amount of rot on the rows where the one or the other material was used for the later sprayings. This suggests that so large a difference in yield must have some other rational explanation. All things considered, the most rational hypothesis is based upon an observed greater plumpness and fullness of the clusters, indicating larger grape berries. This would arise if the Soda Bordeaux exercised a favorable or stimulating effect upon the foliage which, at this time, is the hypothetical explanation we have in mind.

#### EAU CELESTE NOT A DESIRABLE SPRAY MIXTURE.

Despite the oft repeated warnings of this Station against the use of eau celeste, based upon its injury to the foliage, some vineyardists persisted in using it to their loss. This eau celeste, called usually by the vineyardist the "ammonia and vitriol mixture," is not as efficient in preventing fungous diseases as Bordeaux mixture or ammoniacal copper carbonate, and is very liable to injure the foliage.

The vineyardists who used it on grapes injured many of the leaves, and from this cause the grapes ripened unevenly and unsatisfactorily, and besides they were often deficient in quality.

#### THE NUMBER OF SPRAYINGS REQUIRED.

The results in this line are more or less conflicting when compared with last year. It is desirable to warn vineyardists against hasty conclusions from the results upon portions of the vineyard where certain sprayings were omitted. Whereas in 1900 the omission of the spraying just before blossoming was disastrous, this was not so in 1901; see row 3. Further, during 1901 the

omission of the three later sprayings, rows 9 and 22, do not show a decisive loss from rot. *Nevertheless, the omission of these same four sprayings just cited may be expected to end disastrously under ordinary conditions.* As in 1900, so in 1901, the sprayings earlier than when the shoots are 1 to 2 feet long, that is earlier than just previous to blossoming, show no advantage. Yet the vineyardist may need to make a spraying on the swelling buds or on shoots 1 to 2 inches long, to get his spray pump all ready for the spraying just previous to blossoming which must be made at all events, and usually in a hurry. As indicated in Bulletin 123, the sprayings from the close of blossoming onward should be made at weekly intervals, especially in critical weather. Some of the differences observed and just commented upon in comparison with 1900, may be found attributable to the fact that this was the second season during which sprays were applied to this vineyard; it is well, therefore, for those who spray for the first time in rot infected vineyards to be rigorously exacting in making the full number of applications and in doing the work thoroughly at all times.

#### THE SPRAY NOZZLE MUST BE DIRECTED.

Traction sprayers are effective when a good pressure is maintained and the nozzles attached to the ends of hose lines of considerable length, say 20 to 25 feet, are well directed each by a careful person. The mere driving of a sprayer through the vineyard does not insure results; the spray must reach the clusters to be effective. Good air pressure sprayers are a great desideratum for all kinds of spraying, whether by traction or otherwise.

#### THE OUTLOOK.

In addition to the results of the experiments recorded herein, much spraying was done by private parties, and much more of it was successful than in 1900. Upon such varieties as Niagara, Catawba and others quite susceptible to rot, the results were not usually satisfactory; the amount of rot was often greatly reduced on these sorts, but by no means all prevented. The same state of facts was found to exist with some who were spraying for the first time on vineyards of Concords.

On the whole the outlook is very encouraging from the standpoint of rot prevention by the methods of spraying discussed in this paper; for careless spraying irregularly and inefficiently done there is little promise of entire success. As was already stated, the spray nozzle must be directed and the lessons of promptitude and thoroughness well learned before all round success is assured. Nor are these beyond attainment by any careful man accustomed to the ordinary operations of the farm and orchard when approached in the spirit which animates all successful Americans, namely, that of full accomplishment. On the other hand, there is a limit fixed

by the maturity of the fruit, beyond which it is not safe to go in spraying operations. The principle that if a regular series of operations prove good more will be better, may not be a safe one. This applies to the use of Bordeaux mixture after July 20, save on very late grapes, because of the great adhesiveness of this mixture and the spotting of the fruit which results from the late use of it; for the later operations it is possible to use ammoniacal copper carbonate or Soda Bordeaux mixture safely and effectively up to about August 12, on Concords. With respect to later varieties like Catawba, an additional spraying with Bordeaux mixture is permissible and probably advisable where the rot is very bad; following these five treatments with Bordeaux on a late sort it may yet be necessary to make three additional sprayings with either Soda Bordeaux or ammoniacal copper carbonate. It will be noted that this applies to very late varieties only.

The removal of vineyards has ceased for the present, or largely so, and with fair markets the future is much brighter for Ohio grape growers than for a few years past.

#### TO MAKE SODA BORDEAUX MIXTURE.

Copper sulfate, 4 pounds.

Commercial caustic soda, soda lye (sodium hydroxid) slightly in excess so that mixture is alkaline—according to strength, 1 pound, 2 ounces to 1 pound, 8 ounces.

Water to make 50 gallons.

Warning: In each case of change of grade or brand of commercial caustic soda it will be necessary to test the strength. Keep mixture well agitated.

#### TO TEST STRENGTH OF CAUSTIC SODA.

Provide for use both red and blue litmus papers, cut in strips, a pint cup, as well as a measure to contain a fourth of this cup, such as a 4 ounce bottle from drug store. [A 16-ounce druggist's graduate will serve as both measure and fraction.] Also if convenient a gallon glass battery jar. The copper sulfate and caustic soda to be used should be at hand; the caustic soda may be bought in 5 pound and 10 pound tins.

Dissolve 1 pound of copper sulfate in half a gallon, or less, of water and if heated allow to cool. Make a second solution of 1 pound of copper sulfate in about a half gallon of water, in glass, earthen or wooden vessel. Then dissolve 1 pound of caustic soda in 3 pints of water in a glass or earthen vessel and after cooling make up to exactly 4 pints\* of solution. Stir both cool solutions well before proceeding, using a wooden paddle.

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\*The word "pint" is here used to mean the cupful measure, whether exactly a pint or simply a common tin cup. The same cup or measure is to be used throughout and always filled the same.

Now into each of the copper sulfate solutions, with stirring, pour one pint cupful of the cool caustic soda (lye) solution and an additional half cupful to the first copper sulfate solution and allow to settle.

Test this first vessel with blue litmus paper; should the litmus turn red upon being dipped into the clear liquid at top of solution, not enough lye has been added. A half pint of lye solution is now also added to the second vessel with stirring. If the solution in the first vessel does not turn blue litmus paper red but does turn red litmus blue, enough lye solution has been added and possibly too much. In that case add only one-fourth pint, or less, additional lye solution in portions, with testing, as described below, instead of half a pint to the second vessel.

Now in either of these cases we wish to find out just how much more lye solution will be needed; for this purpose use the bottle or measure holding one-fourth a pint and add only a part at a time; stir, allow to settle a little while and test as above. [In case the 16-ounce graduate is used, the second graduate of lye is added in 1 or 2 ounce portions with testing.] Finally when the amount of lye solution has been found which will render the vitrol solution just alkaline enough to turn red litmus paper blue the result is reached.

Since 4 cupfuls, or pints, of caustic soda solution here contain 1 pound of the caustic soda, *the number of pints or cupfuls, or fractions of this solution used to act on 1 pound of copper sulfate in solution, will be the number of pounds and fractions of caustic soda to use for 4 pounds of copper sulfate to make 50 gallons of spray mixture. To this add 1 ounce more of caustic soda for each 50 gallons to insure alkalinity.* Thus if  $1\frac{1}{2}$  pints, plus one-half of one-fourth a pint more or  $\frac{1}{8}$  a pint ( $\frac{1}{2}$  of  $\frac{1}{4} = \frac{1}{8}$ ) of lye solution is used  $1\frac{5}{8}$  pints have been needed and  $1\frac{5}{8}$  lbs. or 1 lb. and 10 oz. plus 1 oz. equal to 1 lb. and 11 oz. of caustic soda will be required for each 4 pounds of copper sulfate used.

If only  $1\frac{1}{4}$  pints of lye solution plus one-half of one-fourth pint ( $\frac{1}{2}$  of  $\frac{1}{4} = \frac{1}{8}$ ) or  $1\frac{3}{8}$  pints of the lye solution in all have been used, then  $1\frac{3}{8}$  pounds or 1 lb. 6 oz. plus 1 oz., or 1 lb. 7 oz. of the caustic soda will be needed for each 4 pounds of copper sulfate in 50 gallons of mixture. Or by calculations in the first case  $1\frac{5}{8}$  pints of lye solution is needed to neutralize 1 pound of copper sulfate; 4 pounds of the sulfate would require  $4 \times 1\frac{5}{8}$  or  $6\frac{1}{2}$  pints. But each pint contains  $\frac{1}{4}$  pound of caustic soda and  $6\frac{1}{2} \times \frac{1}{4}$  gives  $1\frac{3}{8}$  or  $1\frac{3}{8}$  pounds of caustic soda. Add as before  $1\frac{5}{8}$  pounds, or 1 pound 10 oz. plus 1 oz. is equal to 1 lb. 11 oz. for each 4 pounds of copper sulfate in 50 gallons of mixture. In the second case, by calculation,  $1\frac{3}{8}$  pints of caustic soda solution are required for 1 pound of copper sulfate; 4 pounds of the sulfate would require  $4 \times 1\frac{3}{8}$  or  $5\frac{1}{2}$

pints. But each pint contains  $\frac{1}{4}$  pound of caustic soda, so that  $\frac{1}{4} \times 5\frac{1}{2}$  is equal to  $1\frac{3}{8}$  pounds, or 1 lb. 6 oz. plus 1 oz. gives 1 lb. 7 oz. of caustic soda for 4 pounds of sulfate in 50 gallons of mixture. Where the testing is done accurately, an excess of 1 oz. of caustic soda in each 50 gallons may be allowed without risk, as the mixture must be alkaline. This test needs only to be repeated when a new lot of caustic soda is secured. This second result is what we find for the goods used in 1901 by the Station. The second copper sulfate solution is to check up results by. These test portions can be used in spraying.

To keep Caustic Soda: After opening a container and testing, weigh out the entire contents into portions such as are needed to make a single spray tank of mixture; put in Mason jars under shelter, cover with a pint or so of water and this portion is ready to be used when needed. Opened packages of caustic soda will absorb water and increase in weight on standing; unopened packages will usually keep for a year or more.

Suggestions: It will be wiser for extensive spraying work to purchase the caustic soda put up in 5 pound and 10 pound tins although the common soda lye sold by grocers in 1 pound tins, such as Mechling's Soda and Lewis Lye,\* may be used in small operations.† That used by us was labeled "Highest Test Powdered Caustic Soda," put up by E. Myers Lye Co., St. Louis, Missouri, and purchased in Columbus, Ohio.

Similar goods can be bought of wholesale druggists, such as the General Apparatus and Chemical Co., Strong & Cobb and Benton & Myers, Cleveland, Ohio, Laubach & Boyd and Zimmerman & Co., Wooster, Ohio, and the Kauffman-Latimer Co., Columbus, Ohio. Those desiring to purchase would do well to purchase in lots of 100 lbs. or more, at a time, preferably in 500 lb. lots, clubbing together.

The composition is so variable that only lots of the same brand purchased together may be assumed to be uniform. When lots of 100 lbs. or upward, are purchased together the Station will, if all expense of express charges are borne by sender, test a sample can forwarded to us. The Station will not test samples of lots in advance of purchase. It is far better, however, for each one to test his own lot of caustic soda, because in this lies the only real trouble attending the use of Soda Bordeaux mixture. Unlike the regular Bordeaux mixture there is no straining save only such as may be needed to catch grain, etc., that may be present in the solution. Of all spray mixtures, save alone copper sulfate by itself, Soda Bordeaux mixture involves the least trouble and delay in use where

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\*We are not prepared at present to recommend potash lyes as these would make a potash not a Soda Bordeaux mixture.

†By our tests a 1 pound can of Lewis Lye, holding 12.1 oz. dry caustic soda is to be used in the proportion of 1 pound 2 ounces to 4 pounds copper sulfate, that is, a one pound can will make thirty-three gallons of our Soda Bordeaux. A 2 pound can of Mechling Bros. soda containing  $31\frac{1}{4}$  ounces dry caustic soda is to be used in the proportion of 1 pound 13 ounces to 4 pounds copper sulfate; or a 2 pound can Mechling will make 52 gallons of the Soda Bordeaux.

the caustic soda strength has once been determined. Druggists and dealers in materials will doubtless aid in this testing when the materials come into general use. The actual testing is not tedious—the description of it may be.

Caustic soda when exposed to the air soon absorbs moisture and greatly increases in weight. To avoid errors due to this source, the large tins should be opened with a can opener of the sort which cuts a circular, smooth hole, and the diameter of the hole cut should be such as is fitted by a large cork already at hand. The whole is corked up until after the testing is completed. The caustic soda is then all weighed out in the proper portions for each barrel or tank of mixture in which it is to be used; these portions are then kept indoors in Mason jars covered or uncovered, with the addition of a pint or more of water. The lye then dissolves and is ready for use whenever needed, as it will keep indefinitely, save that if kept where too much water be present the jar may overflow and cause loss. Unopened tins of caustic soda will keep a year if dry.

For other spray directions see the spray calendar issued by the Station. (See Bulletins 102 and 121.)

CALENDAR OF STRIKING DATES IN GRAPE CULTURE FOR GENEVA-UNIONVILLE DISTRICT, OHIO, 1899-1900-1901.

Operations and development	Dates 1899	Dates 1900	Dates 1901	
Grape buds unfolding.....	May	8 May	10 May	6
First spraying of spray calendar, second of 1900 and extra of 1901.....		May	8-10 May	10
Frost injury.....	May	22 May	11	
Second spraying of calendar, third of 1900 and first of 1901.....		May	28 May	30
New shoots one to two feet long.....	May	27 May	28 June	5
Grapes blossoming.....		June	11 June	20
Slightly destructive flower blast.....			June	25
Grapes out of blossom.....		June	20 June	30
Black rot prevalent.....		June	15-22 July	1
First light summer pruning.....			July	1
Third spraying of calendar, fourth of 1900 and second of 1901.....		June	22-23 July	3
First observed rot of berries.....	June	27-29 June	25 July	3
Fourth spraying of calendar, fifth of 1900 and third of 1901.....		July	2-3 July	10
Summer pruned, close.....		July	5-7 July	10
Rot disastrously prevalent.....	July	9-12 August	3-10 July	16-24
Fifth spraying of calendar, sixth of 1900 and fourth of 1901.....		July	12 July	20
Berries about full grown.....			July	24
Sixth spraying of spray calendar, seventh of 1900 and fifth of 1901.....		July	27 July	27
Seventh spraying of calendar, eighth of 1900, sixth of 1901.....		August	12-14 August	3
Seventh spraying of 1901.....			August	12
Third rot period; destructive to unsprayed grapes only.....			August	17
Concords coloring.....		August	21 August	20
Began picking early varieties.....		Aug. 29	Sept. 1	Sept. 1 and later
Began picking Concords.....		September	10 September	19
Completed picking Concords.....		October	20 October	20

## THE RELATION OF GRAPE SPRAYING TO PUBLIC HEALTH.

By A. D. SELBY.

In view of certain questions raised with respect to the propriety of marketing grapes that have been sprayed with fungicides to prevent grape diseases, a statement was prepared at the suggestion of the Ohio State Dairy and Food Commissioner, Hon. J. E. Blackburn, for publication in his report for 1901, from which I quote the following extracts:

### SPRAYING GRAPES WITH FUNGICIDES.

Upon the suggestion that grapes sprayed with fungicides, which are certain copper compounds, may render the fruit unwholesome for use as dessert and of possible danger in the making of wine and jelly, I am pleased to submit the following considerations. These will be discussed in connection with the determinations of copper made upon sprayed grapes sampled September 11, 1900, and examined by P. L. Hobbs, Chemist of the State Dairy and Food Commissioner.

### THE PROBLEM OF SPRAYING GRAPES—NO ELEMENT OF FRAUD INVOLVED.

To eliminate from the question such considerations as usually attain in the case of canned goods where copper compounds may be used to freshen and increase the value of otherwise unmarketable goods, I would call attention to grape spraying as in no wise warranting an assumption of fraud. Grape spraying, as now practiced in Ohio, is to prevent the grapes from destruction by rot. The history of grape growing in Ohio shows that since 1897 grape growers have suffered heavy losses from rot until production was very small in 1899 and 1900. The grape grower was faced by the alternatives of spraying, of reaping no return from his vineyards or of removing his vineyards after years of labor and expense in securing them. Compounds of copper had been found to prevent grape rot when sprayed upon the vines and clusters at the proper times; such spraying was accordingly recommended by the Experiment Station, when its attention was called and its aid solicited in 1899. Certainly the aid of the State is due the grape grower whose crop is thus threatened. \* \* \* \* [To show how closely the recommendations of the Experiment Station and the practices of the vineyardists are correlated with the occurrence of rot, the calendar of striking dates given on page 42 was included. It was pointed out that the spray must be applied late enough to be effective against rot prevalence in August. Also that the more easily removable ammoniacal copper carbonate or Soda Bordeaux mixture was used for the fifth, sixth and seventh sprayings so that the spray deposits will be removed by natural conditions.



The benefits from grape spraying were stated by giving a summary of the results of the experiments from pages 34-35 of this bulletin.]

PROPERLY SPRAYED GRAPES NOT DELETERIOUS WHEN USED AS DESSERT.

While admitting that copper compounds of the sorts used in spraying grapes may be applied to grapes in such a manner as to render them unacceptable upon the market and possibly deleterious, it is held that those sprayed according to the directions and practice of the Experiment Station are not so. The reason for this judgment is the knowledge that no members of families of my acquaintance, in which sprayed grapes have been habitually used, have suffered any ill effects attributed to this cause. Indeed, the sprayed grapes from the Station vineyards in Wooster are sought after by citizens above any and all other grapes on the market at the same time. The same appears to be true in relation to properly sprayed grapes in the large markets. The writer prefers such grapes for himself and family, long use having demonstrated the superior quality and the absence of danger.

Of the analyses reported, your number 729, shows the largest weight of copper on the berries, amounting to .0004 grammes of copper upon 100 grammes of berries. This amount is in excess of that found upon any ripe samples of grapes taken by disinterested parties and from grapes treated according to the Station's directions in 1901. This leads us to conclude that grapes so sprayed are not injurious, and that the stated amount can scarcely be counted so; the explanation being that the parts to which the copper carbonates adhere are rejected when the grapes are used as dessert. Indeed, some of the coloring is due to the lime used, which is decidedly conspicuous upon dark grapes.

Upon cup-like or other large leaves against which the spray may be turned, it is the testimony of every one who has engaged in spraying that immensely greater quantities of the copper compounds remain than upon the pendant grape clusters. It is the continuous effort of the vineyardist to get the spray to reach the clusters; despite this the leaves often intervene and prevent the desired result. For the reason stated, spray compounds upon large leaves cannot properly be regarded as an index to the amount upon the clusters.

#### THE NEW YORK GRAPE SCARE OF 1891.

As illustrating how the public mind may be unnecessarily disturbed, the New York City grape scare of 1891 will serve as a good example. The facts are set forth in the report of the Chief of the Division of Vegetable Pathology, U. S. Department of Agriculture, for 1891, pp., 375-6.

The following extract may be of use:

"For the purpose of inspecting the vineyards the board of health, before finally adjourning, decided to send the assistant chemist to the region from which the seized fruit came. In accordance with your wishes, the division was also represented at this inspection, Mr. D. G. Fairchild being selected for the purpose. No facts of importance were brought out by the visit of the assistant chemist and Mr. Fairchild, excepting that wherever vines had been sprayed in accordance with the precautions so many times set forth by the division the fruit was in excellent condition, both as regards freedom from rot and the objectionable deposit. After this nothing further was heard of the matter, and in a week at most the market was in about its usual condition."

In conclusion it may be proper to observe that the evidences of improper spraying upon the grapes are so conspicuous that whatever danger, if any, may attend their use is largely neutralized by this fact and by the almost certain rejection of the fruit by those desiring to purchase.

#### COPPER COMPOUNDS PRECIPITATED IN WINE FERMENTATION.

I have myself made no experiments in the use of sprayed grapes for wine making, but deem the very careful experiments of Dr. Freidr. Krueger, of Berlin, published in 1894, as conclusive on this point. The article is entitled, "Concerning the Influence of Copper Sulfate upon the Fermentation of Grape Must by *Saccharomyces ellipsoideus*" (Ueber den Einfluss von Kupfervitriol auf die Vergarung von Traubenmost durch *Saccharomyces ellipsoideus*) and was published in "Centralblatt für Bakteriologie und Parasitenkunde—Zweite Abteilung, 1:10 and 59, 1895.

The author investigated this question because grape spraying with Bordeaux mixture had become customary. He sought to learn, first, the effect of the presence of copper upon the rate of fermentation, and, second, whether copper remained in the wine in injurious quantities when present in the must.

His conclusions are stated as follows, 1:64-65 (I have thought best to translate the passage):

"By the foregoing described experiments it is proved that Biernacki is correct in maintaining that copper in small quantities influences fermentation by hastening it.

"Further, it appears, according to the results obtained, that the line of demarkation at which the presence of copper prejudices fermentation is usually different for the different sorts of must; that in the different musts different amounts of copper, at the beginning of fermentation, or just before the beginning, enter into an insoluble and consequently an inert (copper) compound, in consequence of the presence of greater or less amounts of organic acids. From this condition it is likely that the copper of the must, arising from the spraying of the grapes, is without any importance for the wine."

Personally, I should have no fears upon this point. It disposes of both the copper spray upon the grapes and upon the stems.

#### SPRAYED GRAPES NOT DANGEROUS IN JELLY MAKING.

Some fear has been expressed concerning the possible presence of injurious amounts of copper in jelly from sprayed grapes. It is patent to all that if both stems and berries are cooked together

previous to pressing out the "juice" there would be full opportunity to dissolve the copper compounds if any be present upon either grapes or stems. When this question was submitted to me a year ago I could find no record of experiments covering this issue. It was accordingly arranged that a trial be made. It would not be unreasonable to expect that in the heating of the whole, the copper and organic acids both being present, some tendency to form insoluble copper compounds might accrue. On this point no direct information was obtained.

For the jelly experiment, grapes which I had condemned as unmarketable were selected. These were of a lot sprayed with Bordeaux mixture August 25, against my advice, but chiefly for purposes of experimentation. They were covered with the spray and would have been rejected on the market as improperly sprayed.

One hundred grammes of the grapes and stems contained .00084 grammes of copper.

As they were quite ripe at the time, the grapes and stems were cooked together, and the juice, after extraction evaporated to the necessary consistency to make jelly. In 100 grammes of the incinerated jelly .00018 grammes of copper was found, thus indicating that but 21.5 per cent. of the copper in the grapes found its way into the jelly, or a little more than one-fifth.

It may be remarked in this connection that in case green grape berries are used only the amount upon the berries and not that upon the stems would come into consideration. The stems, in fact, have an average weight of less than 2 per cent. of that of the clusters of grapes. As to this jelly in question it has been eaten by two or more members of the Station staff in the quantities usually taken without the discovery of an unfavorable symptom attributable thereto. The experiment is stated not as a procedure I would recommend in jelly making, since properly sprayed grapes are to be recommended, but because it was necessary to get more facts upon this subject.

In conclusion I am constrained to state that the Experiment Station has desired to put forth only the exact truth concerning this matter and wishes at all times to be guided by this standard, and knowing that this spray treatment is saving the grape crops of the vineyards of Ohio, and being convinced, as are its officers, that the properly sprayed fruit is wholesome and without menace either to individuals or to the public in general they feel not only justified by the facts at hand, but impelled by the duty imposed through the relations to the fruit growers to continue the recommendations and practices in the spraying of fruit with fungicides.

## SUMMARY.

Co-operative spraying experiments for the prevention of grape rot in a commercial vineyard and covering an area of more than seven acres yielded very satisfactory results in 1901.

Seven sprayings were applied at a calculated expense of \$7.10 per acre; the first of these immediately preceded blossoming and after the setting of the fruit they were repeated at weekly intervals.

While the unsprayed area yielded only 792 pounds or 99 baskets of eight pounds each, of inferior wine grapes, equal sprayed areas yielded a little more than 300 baskets of fine grapes which brought \$30.50, including baskets.

The return, per acre, from unsprayed area is calculated at 316 baskets per acre worth less than \$10.00 per acre, while from the sprayed areas the average yield was 1,252 baskets per acre worth \$125.20 per acre.

Soda Bordeaux mixture made according to directions contained in this bulletin and used to replace ammoniacal copper carbonate for the later sprayings gave apparently better results than the usual treatment with Bordeaux mixture followed by the copper carbonate. This mixture made from copper sulfate and commercial caustic soda or soda lye is accordingly recommended for further trial.

Warning is given against the use of eau celeste because of injury to the grape foliage.

A statement of the relations of spraying grapes with fungicides to public health is also included herein.