Bulletin No. 31 February, 1902

University of Idaho

Agricultural Experiment Station

Department of Botany

SOME SPRAYING EXPERIMENTS FOR 1901

By

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NORTH IDAHO STAR PRESS

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BULLETINS.

The regular bulletins of the Station are sent free to all who request them. Late Bulletins are:

28. Some Idaho Soils.
29. (1) Annual Report of Director for 1898-1900. (2) Meteorological Records.
30. The Service of Soils.

SOME SPRAYING EXPERIMENTS FOR 1901.

Powdery Mildew—Peach-leaf Curl—San Jose Scale.

For several years the Powdery Mildew of the Grape has been increasing along the Clearwater and Snake Rivers, both in the number of vineyards attacked, as well as in the individual damage. Places occasionally visited in the past are now regularly attacked by this disease, and the damage is very considerable both to the appearance of the crop as well as to its value. In the summer and fall of 1901, the vineyard of Mr. L. A. Porter near Lewiston, which had been but slightly subject to the disease in previous years, was violently attacked by mildew, and the whole or nearly the whole of his crop of European grapes was utterly destroyed, entailing on the owner an estimated loss of from $1500 to $2000. Specimens were sent to the writer and he was asked to visit the vineyard. Hardly a vine or bunch of grapes could be found free from the disease, the leaves were shriveled, the grapes spoiled by cracking, (in the majority of cases the husks alone remaining, the pulp having entirely disappeared,) while the whole atmosphere was permeated by the fetid and mouldy odor of the mildew. Not a vine of the Concord or other American strains could be found seriously affected, the whole burden of the loss being conferred upon the European or Vitis vinifera strains.

Early in the spring of 1901 the writer made preparations for conducting spraying experiments in this vineyard. It was planned to spray with several fungicides and if possible find out by this means the best one for our dry hot valleys. The sprays to be used were Bordeaux mixture, Cupram or Ammoniacal Copper Carbonate, and Potassium Sulphide, while these were to be ac-

companied by and compared with dry sulphur dusted upon and under the vines. The formulae used were the common ones, as follows:

BORDEAUX MIXTURE.

Copper sulphate—6 lb
Good lime—4 lb
Water—45 gals.

POTASSIUM SULPHIDE SOLUTION.

Potass. Sulph.—1 lb
Water—45 gals.

AMMONIACAL COPPER CARBONATE (CUPRAM).

Copper Carbonate—5 oz
Strong Ammonia Water of Commerce—3 pints (26° Baume.)
Water—45 gals.

The Copper Carbonate was prepared by the writer. The sulphur was the best and finest "flour of sulphur" and was applied by means of the following container. A tin box about the size of a small baking powder can, with perforated and removable top, was continued down into a thick vertical handle. By this box the sulphur can be distributed thickly or thinly, according to whether it is held nearly vertical or at an angle, and when emptied can be easily refilled by removing the top, which should fit tightly enough to prevent its coming off when the sulphur is being jarred upon the vines.

In making these applications two rows were selected from each kind of grapes. Mr. Porter had all the remainder, by far the largest part of the vineyard, treated to two liberal applications of sulphur. In this way every vine in the two large vineyards, save the checks or controls in the rows selected for the experiments and the rows of American grapes, was treated to at least two applications of some fungicide. The different varieties of grapes taken for the experiments were:

1 Flame Tokay.
2 Malaga.
3 Black Morocco.
4 Rose of Peru.
5 Muscat of Alexandria.
6 Violet Rose.

7 Black Hamburg.

The two rows of each variety were divided into four parts of a nearly common length, as follows,

1	2	3	4

and were tagged from left to right, 1, 2, 3, 4, etc., thus using 28 tags on the seven rows. On one vine of each set a check or control was placed, and these vines remained untreated during the whole season.

Both checks and tags were made of tin, painted white, and with the number in black upon the latter. The former had the word "check" painted upon them. In selecting the vines upon which the checks were placed, it was kept in mind that the fungus starts best in shaded, moist places, and consequently large strong vines were selected.

Life History of the Mildew.

And now before we can comprehend the reasons for the best times for spraying, we must consider briefly the life history of the mildew of the grape, and we may say at the same time that this is the history of all the powdery mildews, no matter how much they may differ from one another under the microscope. By the instrumentality of wind, rain, and snow, the spores, which have lain dormant all winter, are scattered over the vines and young shoots in early spring, and germinate as soon as moisture and warmth are given them. They would consequently begin to germinate about the time the first buds and shoots appear on the vines. Of the millions of spores on the ground a few may find just the proper conditions for growth upon some young shoot or bud. Of the others many may germinate but not finding the proper host-condition soon wither away. If the spore find the proper combination of warmth, moisture and young host-sprout,

it germinates, sends out a delicate hyphal branch, and this coming into connection with the young skin of shoot or leaf, sends suckers or "haustoria" into the tissues of the grape, extracts the juice of the latter for its own benefit, and then grows so rapidly that the net-work of the fungus, called "mycelium," becomes apparent to the eye as a delicate white covering, resembling the finest spider's web. It can also be detected by the curling, and eventually by the discoloration of the leaves and young shoots. By this time the fungus is forming and scattering its first or "summer" spores. These resemble, under the microscope, barrels piled end to end, and several of them are borne on a stalk which proceeds at right angles from the mycelium of the fungus. The bodies are called "conidia" and the supporters of the bodies "conidiophores." It is these conidia which do the greater part of the damage to the vineyard, for they are produced in immense quantities, are light and thus easily transported by the wind, and germinate within a few hours after finding the proper lodgment with proper conditions of heat and moisture. In this way the disease is easily and surely carried from vine to vine, and it can be readily conceived that a few winter spores having germinated in conditions proper for growth and reproduction could easily through the conidia or summer spores contaminate a whole vineyard. A couple of interesting cases of this spreading will be shown in the experiments. Later in the season, about the first of September in Lewiston, another kind of spore begins to form in inconceivable numbers. These are called the "perithecia" or winter spores. At first white, then yellow, and then a blackish brown, they can easily be seen by the naked eye, resembling specks of black pepper, while the mycelium of the fungus might be likened to salt, over and through which the pepper like specks of the perithecia can be seen in immense quantities. It must be remembered that all parts of this fungus are *superficial*; none are within the tissues of the host. For this reason the mildews are much more easily controlled than many of the diseases which enter into the tissues of the plant attacked.

After the perithecia have matured in any considerable quantities, spraying may as well be abandoned, for none of the sprays as commonly applied would have any effect upon them, and for the following reasons. Each perithecium is a round body, just discernible with the eye, but having a definite and rather thick wall. Within this body are delicate membranous sacks and these sacks contain several spores called "ascospores" to separate them from the summer spores or "conidia." The purpose of these ascospores is to carry the fungus over winter, for which purpose the thick wall of the perithecium, the sacks of membrane, and the thick walls of the ascospores are beautiful adaptations. Yet under the combined influence of rain and sun these perithecia decay, disgorge the spores, which through their thick cell-walls resist the cold of late winter and early spring, and are thus in proper condition for germination and growth when the warm spring rains fall. This completes the life history of this fungus, or of any similar mildew, and brings us round to the place from which we started. In concluding this part of the subject, I may add that the the perithecia of the mildew have a quantity of appendages proceeding from their coats, which differ greatly in the different genera. It is upon the shape of these appendages and upon the number of sacks in each perithecium that the different genera are founded. The appendages upon the spores of this mildew are hooked or even rolled in at the extremities, resembling shepherds' crooks and it is this peculiarity which gives the generic name to the plant, *Uncinula*, or *the plant having hooked appendages.* By some this plant is called *Uncinula spiralis,* by others *Uncinula necator.* The specific name in the one case refers to the spiral hooks or tips to the appendages, in the other to the blighting or destroying effect of the disease upon the grape, especially upon the berries.

Dates and Number of Applications.

The first spraying was given on the 18 and 19 of April and it is

very doubtful whether from the late frosts and backward season the spraying availed much, especially as the vines had but recently been taken from their covering of earth and tied to their supports and wires, and consequently much of the sandy loam of the vineyard was still adhering to them.

The plan outlined, was, naturally, to spray all parts of the rows which were to be treated with the one spray, then those to be treated with the next, and so on. In this way we treated all the parts to be sprayed with cupram, then all to be treated with the potassium sulphide, then those with the Bordeaux mixture, and finally we used the dry sulphur on all the part-rows set aside for this fungicide. The checks or controls were placed in conspicuous places over the vines, so as to run no risk of spraying these vines by mistake. On May 8 the vines, which in the interval had made surprising growth, were treated with a second application of the different mixtures. I had only finished the spraying with the cupram and potassium sulphide, together with a barrel of the Bordeaux, when it commenced raining. It rained hard all that night, and as the morning and afternoon of the 9th, showed no indication of a cessation, I returned to Moscow on the 10th. Sulphur was applied to the whole vineyard by Mr. Porter before my return, excluding the parts sprayed, but including my partial rows, which had not as yet received any application. I returned to Mr. Porter's farm on the 16th of the month, but after mixing up and applying only one barrel of Bordeaux on the vines which had been sprayed but once, rain set in again. Rain continued throughout the 17th, and I again returned to Moscow on the 18th frustrated.

One important observation was noted on this visit, that the ordinary formula for Bordeaux, 6lb. of copper sulphate and 4lb. of lime, had burned the delicate leaves and shoots, and that a weaker mixture must be used.

May 21-23 found me at my post again, and this time no rain interfered with the work. I commenced the spraying Wednesday morning, after having applied the sulphur, and completed the

work at 3 p. m. Thursday. This time the Bordeaux mixture was made up of 6lbs. each of bluestone and lime, and later no injury to the foliage or shoots could be detected as the result of this application or an ensuing one.

On June 20, immediately after the closing of the school year, I returned to the vineyard. I was unfortunate in my time of coming for the men were then in the midst of the picking and shipping of the cherry crop, and no help was available. I left the formulæ with a careful foreman of Mr. Porter's, and I was informed that the application was made the next week. This closed the sprayings for then I was called apon to participate in the work in farmers' institutes.

Observations and Results.

On August 31 I returned to Lewiston, and went through the entire vineyard looking for mildew. In the rows of Flame Tokay no mildew was observable. In the Malagas no mildew could be observed till I came to the checked vine, in the part sprayed with the potassium sulphide. *The vine was badly mildewed, and the disease had spread to several vines adjoining*, though none on the other and opposite row could be found at all effected. In two other cases I found the same thing had occured. Amongst the Black Moroccos no mildew was discernible.

Amongst the Black Hamburgs no mildew was to be seen on the rows treated with Bordeaux and cupram; a little was to be seen on those treated with potassium sulphide, while on those treated with sulphur much mildew was present. These rows were however in the moistest part in the vineyard and here the vines were most luxuriant, and this may have largely conduced to the spread of mildew, and not the different treatment. Amongst the Muscats very little mildew was to be seen; the same may be said of the Rose of Peru; while on the vines of the Violet Rose there was neither mildew nor grapes.

On the whole the state of affairs was very satisfactory, and the grapes, which were just beginning to ripen, promised a full or at least a good crop.

On October 11, I again visited the vineyard in company with Mr. McPherson, State Horticultural Inspector. A good part, if not the most of the crop of grapes had been picked and shipped. On all of the vines some of the late bunches hung; on many of the rows fully one half of the crop remained. Mr. Porter had expressed himself well pleased with the effect of the spraying as well as the sulphuring, and considered that the saving of the majority of the grapes was due to the treatment they had received. I had rather boasted to Mr. McPherson of the efficacy of the treatment, when on coming into the vineyard I beheld signs of the mildew everywhere! Though some of the vines showed but little of the disease, and the Concords and other American grapes none at all, the mildew was very generally distributed, some of the vines giving off the offensive odor characteristic of a severe attack, while their grapes were cracked and even pulpless!

And all this change had taken place in a little over a month!

It could be accounted for only in two ways. First, the fall was very mild, the summer continuing late into Autumn, and the mildew had a fine chance to flourish throughout September and October. Second, though the sprays and sulphurings had been effectual in controlling the disease while they were continued, the applications had been stopped too early in the season, and should have been continued throughout July and August.

Probably the disease would have been better controlled had the treatment been delayed a month at the commencement and continued two months later in the summer.

Effectual as the sprayings had been in delaying the outbreak of the disease and in securing a very fair crop of grapes, they had not been effectual in preventing the mildew from running through the whole vineyard and in ripening an abundant crop for the next year.

Summary.

(1) Of all the sprays used the Bordeaux mixture was the best. Wherever this was used the mildew was much less in evidence than in other places, whether treated with cupram, potassium sulphide or with sulphur.

(2) The Bordeaux mixture of the 6—4 formula was hurtful to the tender leaves and vines, a thing by no means new to station workers, while the 6—6 formula or the 4—4 formula did not burn the foliage at all.

(3) Sprayings conducted only up to July are not late enough in the Snake River territory, and should be continued as late as the last of August or the middle of September. The present experiments did not prove what time is the best season to cease spraying, if this does not vary with different years.

(4) The rows treated with sulphur were not so free from mildew as those treated with cupram.

(5) The rows treated with potassium sulphide were not so free from mildew as those treated with several dustings of sulphur.

(6) American varieties of grapes are very little subject to the powdery mildew in Idaho.

(7) Mildew flourishes in dry, hot, rainless valleys provided the soil is damp by moisture or through irrigation. It is a very common mistake among grape raisers that it needs wet weather to produce much mildew of the grape.

(8) Amongst the European grapes in Mr. Porter's vineyard, the Malagas suffered least, and next the Flame Tokays, while the Black Moroccos and Black Hamburgs were most subject to the disease.

A Spraying Experiment for the Control of Peach-leaf Curl and Incidentally of San Jose Scale, Conducted on the Farm of Mr. Oderkirk near Lewiston.

An interesting and valuable bulletin was published in 1900 by Mr. Newton B. Pierce, special agent of the United States Department of Agriculture, stationed in California. The purpose of this bulletin was to prove that the Bordeaux mixture and the Lime-Sulphur-Salt-wash so commonly used in California aud Idaho as a spray for San Jose Scale, were both very effective in preventing Peach-leaf Curl. This fungus lives entirely within the tissues of the peach leaf when it is mature, but can be attacked successfully just as the peach buds are bursting in spring, and before the threads from the germinating spores of the fungus have gained entrance into the tissues of the leaf. Mr. Pierce tells us that the peach growers of California had noticed for several years that trees treated with the spray for scale were practically free from leaf curl; that trees not treated would be defoliated and bear a poor crop of peaches if any, while those treated in the same orchard produced and held a full crop of green leaves; nay, that where one half of the tree was treated and one half left untreated, the first part bore a full crop of leaves, while the second lost the greater part of them. Mr. Pierce also expressed his belief that the addition of salt has little to do with causing the spray to be effective either with curl or San Jose scale.

The writer of this bulletin thought that a few experiments along this line might be helpful to our horticulturists, not as furnishing any new results, but rather as testing the experiments and hypotheses of Mr. Pierce in our own climate.

Therefore the orchard of Mr. A. Oderkirk near Lewiston was selected, as it was known that the whole place was rather "down at the heels" before the coming of the present owner, and was especially overrun by curl leaf and scale. By arrangement with Mr. Oderkirk, a large iron bottomed tank, capable of holding 70 or 80 gallons of the liquid, was made ready for my coming.

Material was purchased in Lewiston, and on Friday, the 22nd of February, we began the preparation of the spray.

The buds were hardly enough advanced, but as the weather was then beautiful, and a delay might be accompanied by rains, both Mr. Oderkirk and I judged it wiser to make a trial at that time.

The spray was made in the following manner,—the ordinary method of preparation.

In the tank were placed 20 gallons of water, the fire was built, and the water heated to near the boiling point. Then 10lbs. of lime and 20lbs. of sulphur were placed in the tank, and the whole boiled about 1½ hours. I had during the interval of boiling slaked 30lbs. of lime and added to this when slaked 15lbs. of salt. The two mixtures were then placed in the tank, about 50 gallons of water were added and the whole stirred vigorously and allowed to boil hard for ½ an hour, when it was ready for use. It was bailed out of the tank and poured into a barrel through a wire strainer to eliminate the unslacked lime-stones and pieces of sacking so common in sulphur and salt. The solution was made a little stronger than the usual formula prescribes, first because the buds were hardly at all swollen, second because though the skies were clear, the barometer threatened rain. Most of the peach trees in the orchard, owing to lack of cultivation, water and pruning for several years past, had gradually died, and the only ones apon which the experiment could be made was a long row of thickly planted trees which had originally been intended as nursery stock. Some of these were seedlings, some were budded stock, and all of then had been badly effected with curl the previous year. As soon as the boiling spray had cooled sufficiently to allow of its passing through the rubber hose without damage to the latter, but while it was still hot, we sprayed thoroughly one side of the row, and then came down on the other side. In this way every tree, save two or three which were left as checks or controls and were not sprayed at all, was dripping with the warm spray, and though all parts of trunks and branches were covered, special attention was given to soaking the buds. On the morning

of the next day every tree had completely dried, and they looked as if they had received a coat of yellowish white-wash. Besides the controls left in the main row, a few scrawny and sickly specimens were left in what was once a second row, but in which most of the trees had died, or from which many had been removed to be planted in other places.

The next morning more spraying material was prepared, but the salt was not added to a portion of the mixture till it was placed in the barrel, in order that another portion might remain unsalted. With the first a few half dead peach trees in a different part of the orchard were sprayed. With the unsalted mixture a couple of apple trees, very badly affected with the scale, were sprayed, to determine if possible whether the salt was helpful in killing scale or even helpful in causing the lime and sulphur to remain on the trees. To be sure that the scales were alive and not dead, many were removed with a pen-knife, when the yellowish living bodies could be plainly seen. Other places on the tree were tried by running the nail of the thumb over a considerable area of the scales, when the moisture following the nail and upon it proved also that the scales were alive.

A few half dead peach trees were likewise sprayed with this mixture to prove if possible whether the absence of salt was also efficacious in checking the peach curl.

Results.

In June I visited the orchard again to learn the results of the experiments. It was rather late for making observations in regard to the curl, but my other experiments at the farm of Mr. Porter, and the additional fact that the river had been very high and most of the ferries had disappeared, rendered an earlier visit impossible. Fearing the possibility of such obstacles arising, I had left word with Mr. Oderkirk to make careful examination of the peach trees from time to time and note results.

He assures me that he made personal examination of the trees several times, and that the absence of curl on the sprayed trees was remarkable. At the time of my visit the sprayed trees were covered with luxuriant foliage, and peaches were abundant. Hardly any old curls could be found either on the ground or hanging upon the trees, while under and upon the unsprayed trees in the partial row and on the controls the dead and malformed leaves were abundant.

We then made an examination of the other peach trees as well as the two apple trees sprayed for scale. As to the former, so many of them had died that the experiments with and without the salt were inconclusive. In regard to the two apple trees there was not the slightest doubt. The spray of lime and sulphur, minus the salt, could still be seen dimly upon the trunks and branches, *and not a live scale was to be found after most diligent search.*

Conclusions.

(1) The lime-sulphur salt spray is effectual in reducing if not in actually preventing curl on peach trees.

(2) The lime-and-sulphur will kill the scale without the salt addition, and it is doubtful whether the salt is of any material benefit.