

TEXAS AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 23.

NOVEMBER 1892.

BLACK ROT OF THE GRAPE
LIFE HISTORY.
TREATMENT.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

All Bulletins of this Station are issued free. Any one interested in any branch of agriculture may have his name placed on our permanent mailing list, and secure future numbers, by application to

GEO. W. CURTIS, DIRECTOR,
College Station, Brazos Co., Tex.

In requesting Bulletins, write name and address plainly.



BRYAN, TEXAS:
COX, "THE NEAT PRINTER."
1892.

TEXAS AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF.

GOVERNING BOARD,

BOARD OF DIRECTORS A. AND M. COLLEGE.

- MAJ. A. J. ROSE, President.....Salado.
- HON. JNO. E. HOLLINGSWORTH, State Com. Agr.....Austin.
- HON. W. R. CAVITT.....Bryan.
- DR. J. D. FIELDS.....Manor.
- HON. JNO. ADRIANCE.....Columbia.

TREASURER.

- PRESIDENT L. S. ROSS,.....College Station.

STATION STAFF.

- GEO. W. CURTIS, M. S. A.....Agriculturist, Director.
- H. H. HARRINGTON, M. Sc.Chemist.
- M. FRANCIS, D. V. M.....Veterinarian.
- R. H. PRICE, B. S.....Horticulturist.
- D. ADRIANCE, M.S.....Meteorologist, Associate Chemist.
- J. W. CARSON,.....Assistant to Director.
- J. M. CARSON,.....Assistant Agriculturist.
- P. S. TILSON, M. S.....Assistant in Chemistry.

Texas Agricultural Experiment Station.

BLACK ROT OF THE GRAPE.

(*Physalospora Bidwellii*. Sachs.)

(R. H. PRICE, B. S.)

INTRODUCTION.

Perhaps no other subject in Vegetable Pathology has attracted so wide attention since 1885 as the Black Rot of the grape and its treatment. This may be due to the serious loss it has given grape growers, the number of forms of its spores, the associated spores of *Phoma flaccidia* and *Phoma reniformis*, and the experiments with different preparations for its prevention. It has no less than sixteen synonyms* arising partly from its number of spore forms, all of which may not appear at the same place nor at the same time.

With a view of studying its life history, a microscopic study of its dormant period and early growth forms was begun by the writer during the winter of 1891-2 while an assistant at the Virginia Experiment Station, in the Departments of Botany and Horticulture. The microscopic study has been continued here with the discovery of the *spermogonia* and the associated forms, *Phoma flaccidia* and *Phoma reniformis* which I could not find in Virginia at that time. During the three previous summers I had been much interested in the preparation and application of different fungicides for its prevention and noting their effects upon the fruit and foliage of the vine.

Seeing the seriousness of the mildews at the Station here [Texas] with some appearance of Black Rot, and receiving a number of letters from growers in different parts of the state in regard to Black Rot and other diseases of the grape, led me to select this most injurious disease upon the grape and publish the results of my study of it and its treatment, believing that the same treatment for Black Rot, if properly applied, can now be safely recommended for the Brown Rot, the Powdery Mildew, and the Anthracnose as well.

While this bulletin is somewhat preliminary in its nature, in that the work of germinating the spores and infecting the foliage with the different spores was not carried as far as was wished, yet the results reached so far and recommendations here given, will, it is hoped, be beneficial to growers, and they are given now in order that they may benefit them the coming season. It might be stated, however, that during the investigations access has been had to reports of investigations of the disease by the Division of Vegetable Pathology, U. S. Dep. Agriculture, and the French works of Prof. P. Viala and his assistant, M. L. Ravas, the latter kindly loaned me by Prof. B. T. Galloway, Washington, D. C.

*See Dep. Agr., Bot. Div., Sec. of Vegetable Pathology, Bulletin No. 7, p. 17.

The botanical description is necessarily somewhat technical in its nature; still, it is hoped that it will be made so plain as to enable any intelligent farmer to detect the appearance of this malady in his vineyard; and knowing something of its life history he would thereby be prepared to prevent its serious ravages.

HISTORY.

The Black Rot of the grape is of American origin. It occurs upon various species of grapes growing wild in American forests. Specimens of it were collected in Alabama in 1853. Its first appearance in France was not noted till 1885. Since the above mentioned dates its ravages have been very serious, in fact so much so upon many of the *Labrusca* and the *Riparia* families in particular, as to lead many to discard these valuable "table families" from their vineyards.

NATURE OF THE DISEASE.

Black Rot is caused by the growth of a plant upon the affected parts of the grape. This plant can only be seen with a microscope. It belongs to a group of plants known as fungi—that part of the group fungi known as *parasitic* fungi. The plant body (called mycelium) consists of threads which ramify through the tissues of the affected parts, causing discolorations, breaking down of the cells, and finally shriveling of the berry.

Infection takes place by the germination of a *spore*. This spore corresponds to a seed in higher plants. A fungus may have several forms of spores, each capable of reproducing the parent plant. Specialized mycelium which bears these different spores has different names. In Black Rot we have *sclerotia*, *spermogonia*, *pycnidia* and *perithecia*, each producing a different spore.

The discussion of the dormant period of the disease and early growth forms of the spores and spore bearing bodies follows in the order seen from a study of a diseased bunch gathered in the vineyard at the Virginia Experiment Station, Feb. 11, 1892.

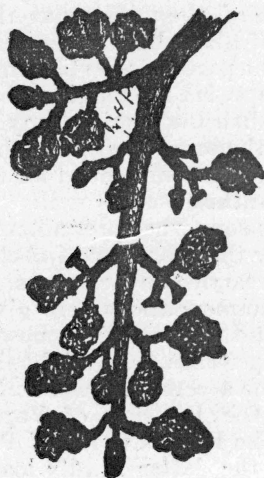


Fig. 1. The bunch as it came from the vineyard. Natural size. Original.

When gathered, many affected bunches were yet adhering to the vines with most of the berries still attached to the pedicels. The color of the berries varied from dark brown to almost black. They had shriveled to about two thirds their normal size, the skin in most instances, being very dark and dry, and "raised into strong, prominent and irregular ridges, pressing closely upon the seeds."

Bluish black, very minute prominences (pustules) were showing thickly over the surface of most of the berries. A few showed none. These minute pustules can be seen with the unaided eye and quite plainly with a common hand glass.

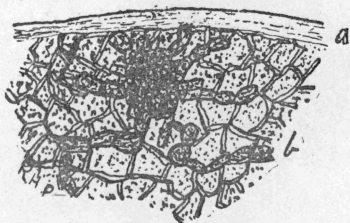


Fig. 2. Section of grape cut to six ten thousandths inch thickness through a sclerotium just beginning to form. a--Epidermis. b--Mycelium showing in the tissue. Magnified about 600 times. Original.

The mycelium as shown in the above illustration is very dark, irregular in diameter, and much septate. This figure represents the dormant mycelium and an immature sclerotium seen 11, Feb. Immature pycnidia and perithecia were also seen then.

CULTURE WORK.

Various methods of cultivating the three forms mentioned were tried. But little success was had in cultivating them in water, Agar-Agar, or in grape decoction made of the leaves, owing mostly to the growth of associated fungi. The greatest success was had by letting the forms fruit in the whole berry. For this purpose specimens of the diseased fruit were washed in a solution of one hundred c. c. of water and one gm. sodium hypo-sulphite to destroy epiphytic fungi. Afterwards they were placed in the green house on sterilized sea-sand and kept under a bell glass and properly moistened with distilled water. From these specimens the development of the early stages of the disease was studied, also a parallel series of observations was made upon specimens in the vineyard. After the diseased berries had been kept in the green house three days the mycelium disappeared from inside the tissue. The temperature ranged from 50° to 80° Fah. In eight days the sclerotial bodies began to fruit. They had burst the epidermis of the grape, and in many instances were sending out conidiophores (specialized mycelium) from their upper portions. At this stage the sclerotia were rather more oblong than the pycnidia or perithecia and showed a nearly vacant space in the lower portion of the sclerotal mass of mycelium. They are dark conceptacles of closely woven mesh like mycelium growing lighter towards the center.

The conidiophores arise near the tops or upper portions of the sclerotia. They are of a dirty brown color becoming lighter near the tips

where the conidia are borne. The conidiophores are plainly septate. They often seem to have some direct connection with the center of the sclerotia.

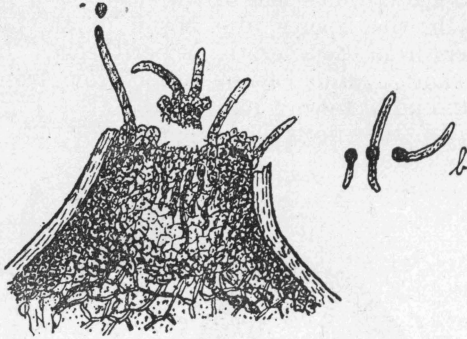


Fig. 3. Fruiting sclerotium. a--Conidiospore borne on a Conidiophore. b--Conidia germinating. Magnified about 400 times. Original.

The conidia are oval hyaline bodies, borne acropetally on the conidiophores. The longitudinal diameter is about one third greater than the transverse diameter. These spores germinated in water on a slide under a cover glass in five days, the temperature varying from 50° to 75° Fah. If the temperature had been kept higher no doubt they would have germinated quicker. The mycelium starts mostly from one end of the spore—occasionally it starts from both ends. It is hyaline (transparent) and shows no septa.

THE PYCNIDIA.

The pycnidium is a nearly round conceptacle in which the pycnospores are borne. Its structure consists of a dense outer wall of closely woven dark mycelium, becoming lighter towards the center, where it is composed of a light, viscid and almost structureless mass of protoplasm. This structure in the center is due to the crowded condition of the immature spores. As the spores develop they grow darker. The pycnidia burst the epidermis of the berry in a similar manner to the sclerotia.

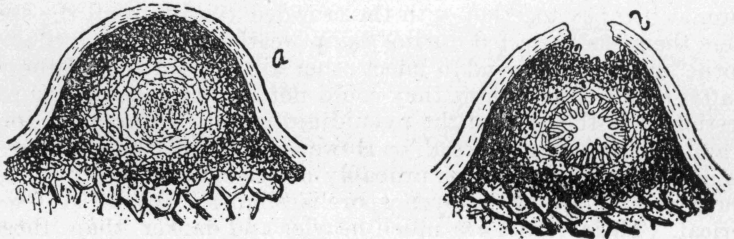


Fig. 4. Two stages in the development of pycnospores. a--First stage. b--Second stage, showing the immature pycnospores borne upon short basidia. Epidermis ruptured at b. Magnified about 350 times. Original.

Pycnospores began to develop in the pycnidia after the diseased berries were kept in the green house four days.

The mycelium which forms the outer walls of the pycnidia seems to be the same in structure as that of the sclerotia or perithecia. The manner in which the spores are borne in the pycnidia clearly distinguishes them from the sclerotia or perithecia. They are borne on the apices of short hyaline basidia which grow from the sides of the pycnidium and point toward its center. (See Fig. 4-b.) As the pycnospores develop they grow darker—when mature they are dark brown.

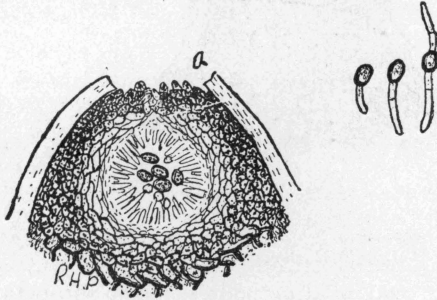


Fig. 5. a--Pycnidium bearing mature pycnospores. b--Pycnospores germinating. Magnified about 400 times. Original.

Mature pycnospores were observed after the diseased berries were kept in the green house six days. Spores were being ejected through the ostiolium (opening) in immense numbers when the diseased berries were immersed in water a short while after the spores had matured. The gradual pressure of the fruiting forms against the epidermis of the grape during their growth causes it to burst. This opening of the epidermis above the fruiting forms, with their loose structure at this point, admits of easy exit to the spores.

After the sections had lain in water two or three days a slight pressure upon the cover glass would cause the pycnidia and perithecia to open down into their interior, leaving no obstruction whatever to the exit of the pycnospores and the asci. This loose structure of the pycnidium at its apex together with the crowded condition of the spores, renders them easily ejected during damp weather; afterwards they may be borne away by the wind to infect other vines. During all the work and after many observations they could not be found issuing through the ostiolum at the apex of the pycnidium in the "form of a continuous and twisting white thread." However, Prof. Scribner states that "this manner of protrusion is probably not constant."

The general shape of the pycnospore is slightly ovoid. A few are spherical. Their walls are much heavier and darker than those of the conidia and their size is about three times larger. Their nuclei and granules of protoplasm show quite plainly. Their germination is similar to that of the conidia (See Fig. 3-b.) while the mycelium is much darker and is septate, becoming hyaline at the growing tip.

When placed in water they germinated in three days—temperature varying from 50° to 75° Fah.

THE PERITHECIA, OR ASCIGEROUS FORM.

While the dormant perithecium is practically the same in structure as the pycnidium, its shape is more ovoid and its outer wall is less dense at the apex, where the asci mostly issue. The asci (spore sacs) grow from a dense white viscid hymenium in the lower part of the perithecium. They are erect and point towards the apex of the perithecium. The dense structure of the walls of the perithecia and the crowded condition of the asci often cause the asci near the walls to curve in their upward growth and to accommodate themselves to their surroundings. The asci are often forced out at the sides of the perithecium and present an irregular curved shape.

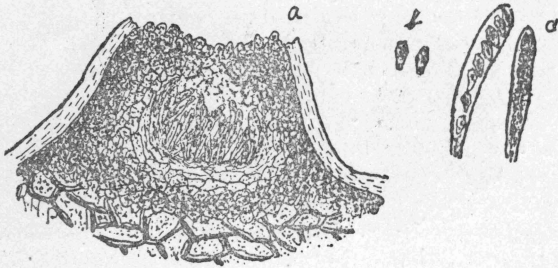


Fig. 6. a - Perithecium showing immature asci. b - Mature ascospores. c - Mature asci, one containing the mature ascospores ready to issue from the ascus. Magnified about 500 times. Original.

At first the asci are filled with dense granular protoplasm which becomes light brown in color and differentiates into spores during the growth of the asci. When mature the walls of the asci are quite transparent and the outlines are not easily distinguished. They are oblong, clavate bodies, possessing eight ascospores. Often they project some distance out from the walls of the perithecium before they eject their spores. The spores occur in the asci, in pairs, which condition makes them somewhat hemispherical while in the asci. If they be ejected from the asci before they have been detached from each other long they hold this hemispherical shape a day or two after they issue, at which time they assume their normal shape. The normal shape is oblong, abruptly swollen near the middle portion and somewhat irregular in outline. The linear diameter is nearly twice that of the transverse (See Fig. 6 -b).

After the diseased berries had been kept in the green house five days the asci began to develop. Mature ascospores were found in the asci fourteen days after the diseased grapes were planted in the green house.

The ascospores were kept in water under a cover glass eight days without germinating, the temperature being the same as that for the germination of the pycnospores.

OBSERVATIONS MADE ON THE GRAPES IN THE VINEYARD.

March 4: Observations made on grapes brought from the vineyard

at this date showed the sclerotia to be fruiting.

March 23. After a snow had lain on the ground one week and the temperature had been down to 12° Fah., pycnospores were found to be ejected in abundance.

April 29. Mature ascospores were found.

PARAPHYSES [?]

Dark, thread-like articulated bodies were found occurring with the asci in specimens brought from the green house April 29. It required some pressure upon the cover glass to force them out. They were found only three times. They varied in length—many were about two-thirds as long as the asci, while others were much shorter. The transverse diameter was about one-half that of a mature ascus, becoming less near the apex; the septa showing clearly. Nearly all the segments were somewhat oval, rather abruptly broad at the base, becoming much narrower where they articulated with the ones above them. Each segment was filled with a dark brown, highly granulated mass of protoplasm. As these bodies were not like any mycelia found, and occurred with the asci in the perithecium, they were thought to be paraphyses. Since the paraphyses have never been found before and these bodies were seen only three times during this investigation; some additional work now under way will be required to establish their identity. It was thought best, however, to publish exactly as seen in order that others who may be investigating in the same direction may have the benefit of our own observations. It may be stated also that one of the original drawings was submitted to Prof. B. T. Galloway, of the Div. of Veg. Path., U. S. Dept. of Agr., who expressed his opinion that the bodies seen were not paraphyses. The appearance of paraphyses [?] with the asci places the disease in the genera *Phyalospora* first given it by Sachs.

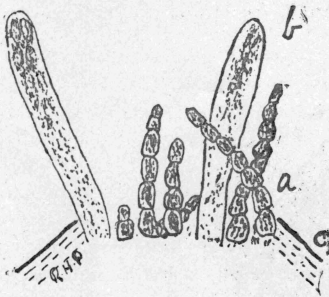


Fig. 7. a-Paraphyses. [?] b-Ascus with protoplasm just beginning to differentiate into spores. c - Epidermis. Magnified about 800 times. Original.

THE SPERMOGONIA.

The spermogonia were found November 19, in specimens from Virginia, sent me by Professor W. B. Alwood. The spermogonia were ejecting their spermata at this date in abundance. A few spermata were also found in diseased berries gathered in the vineyards here [Texas] October 29. The true office of the spermata is, perhaps,

not yet definitely known, but it is now believed by many to be that of propagating the disease also. The spermatia are borne on the apices of long, very slender hyaline sterigmata which radiate towards the center of the spermogonium like the basidia in the pycnidium. The spermatia are oblong, hyaline bodies. They vary somewhat in length. The longitudinal diameter is about four times that of the transverse diameter.

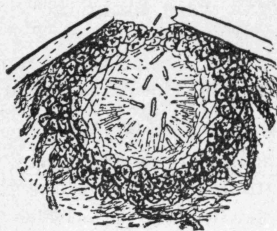


Fig. 8. Spermatia borne in a spermogonium. Magnified about 600 times. Original. [THE ENGRAVER HAS NOT SHOWN THE STERIGMATA PLAINLY.]

As these bodies are developed somewhat early in the history of the disease mycelium is often seen connected with them.

ASSOCIATED FORMS.

In order that the *Phoma flaccidia* and *Phoma reniformis* which are often associated with true Black Rot, may not be mistaken by some for Black Rot, a description of their dormant stages is here given also. These forms could not be found at the Virginia Experiment Station in February, but were found in abundance here in October, occurring in the diseased berries still hanging upon the vines. These fruiting forms are similar in structure to the pycnidia of the Black Rot, and the spores issue through the ostiolum in a similar manner.

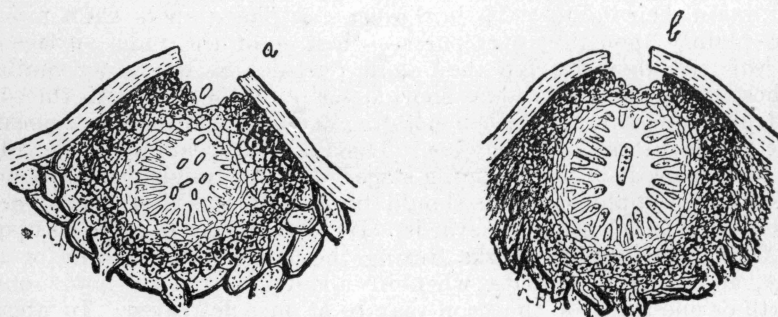


Fig. 9. a - Spermogonium bearing spermatia. b - Pycnidium bearing pycnospores. Magnified about 400 times. Original.

The spermatia are almost transparent, oblong bodies, but little smaller than the conidia of true Black Rot. They are borne on sterigmata which radiate toward the center of the spermogonium similar to the sterigmata of Black Rot.

Pycnospores of *Phoma reniformis* are oblong, with obtuse ends, sometimes slightly kidney shaped. Their color is light brown. They are borne similarly to the pycnospores of the Black Rot. The longitudinal diameter is nearly three times that of the transverse diameter. Their protoplasm is highly granular. They germinated in four hours when placed in water under a cover glass—temperature varying from 60° to 85° Fah.

Spores of *Phoma flaccidia* were found at the same time. They are about two thirds the length of the spores of *Phoma reniformis* which they resemble only in the manner of being borne on basidia and the somewhat granular structure of the protoplasm.

INFECTION OF THE FOLIAGE.

Quite a number of experiments were made with the conidia, pycnospores and ascospores in trying to produce the Rot upon the foliage of the vine which was kept in the green house and moistened several times during the day with distilled water but without success. However, my failure might be accounted for by probably washing the spores off the leaf when moistening it.

That the Rot upon the leaf is the same as that upon the berry was first proven by Messrs. Viala and Ravas—later by Prof. B. T. Galloway. Prof. Scribner states that “the time from the date of the infection of the leaf with the spores to the manifestation of external characters is eight to twelve days.” *

APPEARANCE UPON THE FOLIAGE.

(See color plate, after Neale—used by courtesy of Delaware Station.)

An infected leaf presents to the eye many irregular, dark brown spots (sori). These sori are much lighter in the center, growing more diffuse and darker towards their irregular borders. As they grow they become more irregular in outline, and occasionally unite, but still retain their lighter color in the center. These spots show much more plainly upon the upper surface than upon the under surface of the leaf. As they develop they show pustules in the center similar to those upon the berry. This short description together with the colored plate ought not to fail in enabling one to detect the first appearance of this disease upon the vine. The disease appears upon the foliage first, hence it is the “warning stage.” If the fungicides have not already been applied no time should be lost in applying them when this stage is found in the vineyards. Its next appearance will be upon the fruit in two or three weeks during the latter part of June or in July, according to climate, when in about twenty-four hours one-fourth or one-third of the crop may be at once destroyed. In about twelve days after the first destruction of fruit another will take place.

APPEARANCE UPON THE FRUIT.

The disease appears upon the berry when it is nearly grown. It appears first in a small, brown, circular spot. As the spot suddenly grows it becomes deep brownish red in the center where it is slightly depressed. In two or three days the disease will spread over the en-

* See U. S. Dept. Agr., Sec. Veg. Pathology, Bull. No. 7, p. 24.

tire berry, giving it a soft, spongy appearance. Soon the berry will begin to shrink, taking a deeper hue at the point of first attack. In about a week it will be much shriveled and begin to dry, still growing darker till it becomes very black. Little black pustules will now begin to appear upon its surface, giving it the appearance described in the first part of this bulletin. The berry has not rotted but shriveled. The fungus has broken down most of the tissue by absorption, hence the word *rot* is not applicable to the disease. The fungus does not spread from berry to berry, but only attacks a part of the bunch at a time.

RATIONALE OF TREATMENT.

Since the fungus is carried over winter in the tissues of diseased grapes and possibly the leaves also, from which spores are given out in the spring during damp weather, even early in March; the first thing to do is to destroy all leaves, dead grapes, etc., in which disease hibernates.

Since the disease is endophytic, growing inside the tissues of the leaf and of the berry, it cannot be reached by fungicides after it has made its attack without fatal injury to the parts affected, therefore all treatment must be preventive and not remedial.

Anything which may be applied without injury to the leaf or berry and which will prevent the spores germinating is a good fungicide. Minute traces of copper salts, as well as some other things, have been found to prevent the spores germinating with slight injury to the foliage or fruit. Therefore so long as a slight trace of copper salts can be kept upon the parts of the grape during spring and early summer the crop is practically safe from the attacks of the disease. Where failures have resulted in preventing the attacks of Black Rot by the use of copper salts they have been due, mainly, to being applied too late, and also to being washed off by rains. Damp weather which is more favorable to the development of the disease, is the most unfavorable time to keep the preparations on the foliage, therefore spraying should be done more often during rainy weather. It should commence just when the buds begin to swell or open and be applied at intervals of about twelve days till the grapes are half grown. Usually four applications will be sufficient—the last one being applied about fifteen days later than the preceding one.

IS THE SPRAYED FRUIT UNWHOLESOME?

It has been clearly proven by chemical analysis that the very small traces of copper salts which may remain on the fruit when ripe cannot injure health. After application of the Bordeaux four times at the Virginia Experiment Station, the fruit and stems were analyzed by the chemist and "showed only 0.035 ounce of copper to over 500 pounds of grapes" when the crop was gathered. * However, all traces of copper may be washed off by placing the grapes in a large vessel and pouring over them a solution of water and vinegar. Formula:

4 gallons water to one quart vinegar.

* See Va. Agr. Exp. Sta., Bull. No. 15, p. 42.



FUNGICIDES FOR BLACK ROT.

Of all the different preparations for prevention of parasitic diseases upon plants, perhaps the Bordeaux mixture still takes the lead. The following in regard to the Bordeaux mixture upon grapes was received from Prof. T. V. Munson, Denison, Texas, Oct. 19, 1892: "Last year I had remarkably fine prospects at flowering time for a full crop, did not spray and lost nearly everything by Black Rot. This year with poorer prospects and a worse season, saved nearly all the crop with four sprayings of Bordeaux mixture." Dr. A. M. Ragland, Pilot Point, Texas, states that the grapes are injured in his section of the state by diseases from 30 to 50 per cent. "Bordeaux saved 90 per cent." Equally as good results with the Bordeaux have been obtained elsewhere.

FORMULAE FOR PREPARATIONS.

The original French formula for Bordeaux mixture was sixteen pounds copper sulphate (Bluestone) dissolved in twenty-two gallons of water and then mixed with thirty pounds of lime which had been slaked in six gallons of water. This heavy preparation is bad to use through spray machinery. During the last two or three years several experiments have clearly proven that a much weaker preparation does equally as well. The following weak Bordeaux mixture has been very effective at the Virginia Experiment Station during the past three years and it works through spray nozzles quite well. Formula:

- (1) Copper Sulphate.....2 pounds.
Lime (unslaked).....2½ pounds.
Water.....25 gallons.

Prof. B. T. Galloway finds the following formula very effective which is only half his original formula:

- (2) Copper Sulphate.....3 pounds.
Lime (unslaked).....2 "
Water.....22 gallons.

Prof. T. V. Munson used last summer, 1892, in preparing his Bordeaux the following formula:

- (3) Copper Sulphate.....2 pounds.
Lime (unslaked).....2 "
Water.....20 gallons.

While unslaked lime is not recommended, yet if it be used the quantity should be one pound more. If two pounds of cheap glue be added to the above formulæ the preparations will stick on the foliage better.

The Soda-Copper preparation is easier prepared than either of the above preparations and has given good results also. Formula:

- (4) Copper Sulphate.....2 pounds.
Soda Carbonate.....2½ pounds.
Water.....25 gallons.

The following while not quite so effective as either of the above is more quickly prepared and more easily handled but costs more. It is recommended when small quantities only are wanted. Formula:

- (5) Copper Carbonate.....½ ounce.
Ammonia 26° Beaume.....6 ounces.
Water.....4½ gallons.

COST OF THE CHEMICALS.

The wholesale cost of the chemicals will be about as follows:

Copper Sulphate	8c per lb.
Copper Carbonate	40c " "
Sodium Carbonate	3c per lb.
Fresh Lime	35c per bushel.

The cost per acre with the first three formulae when applied four times will be about \$10.00 or \$11.00, varying, of course, according to the number of vines to the acre, their size, and the local cost of the labor.

METHODS OF PREPARATION.

As the chemicals will attack and destroy most metal vessels they should be dissolved in earthen or wooden vessels. They should be dissolved separately and afterwards mixed together. Where large quantities are desired a good way to prepare them is to take two barrels and place in each enough water to dissolve the amount of each of the chemicals used. The chemicals should be kept separate in separate sacks, then let the sacks hang loosely in the water until the chemicals dissolve. The sacks may be kept off the bottoms of the barrels and be easily shaken about to facilitate solution by running a rod or stick through the tops and letting the ends rest on the tops of the barrels. Heating the water first and pulverizing the chemicals will also hasten the solution. Any amounts desired can be made by the formulae by multiplying or dividing them. For small amounts and quick preparation, formula No. 5 is recommended. The Copper Carbonate should first be made into a dough so that it will mix easier with the ammonia.

The Bordeaux mixture is recommended not only for the Black Rot, but for Anthracnose (*Sphaceloma ampelinum*), Brown Rot (*Peronospora viticola*) and Powdery Mildew (*Uncinula spiralis*). The Bordeaux is not recommended as an insecticide yet when it was used on the vineyard at the Virginia Experiment Station the "Rose Chaffer" (*Macrodactylus subspinosus*) did little injury, while at the same time it was very injurious upon many surrounding vineyards. Prof. T. V. Munson states also in a letter of Sept. 19th. 1892. "The Bordeaux mixture will overcome all of the fungi if applied *thoroughly, in time*, as well as the Leaf Folder and most other insects; as I have clearly demonstrated in my vineyard this season. One application about the last of August or just as soon as the crop of grapes is gathered will keep the Leaf Folder's late attack off." The "Leaf Folder" (*Desmia maculalis*) does serious injury here. Should it fail to keep off this predaceous insect, five ounces of London Purple or Paris Green is recommended to be mixed with twenty-five gallons of the Bordeaux. This will make it at the same time an insecticide as well as a fungicide. Burning the leaves *et caetera* which remain in the vineyard will destroy many pupae.

SPRAYING MACHINERY.

In order that a thin film of a preparation may be applied to all parts of the vine it is necessary that some form of spraying pump and nozzle be used. Some form of a spraying machine is needed on every farm. The kind will, of course, vary according to the purpose, size of

vineyard etc. For general green house work or where only a few vines are to be sprayed the Hand Force Pump is recommended. This machine with the improved Vermorel Nozzle which fits on the hose that goes with it, can be bought of Peter Henderson & Co., 37 Cortland St., New York City, N. Y. for \$6.50. For general vineyard work the Jappy Spray Pump is recommended. Perhaps the best style of the improved Jappy Spray Pump manufactured in America is sold by Robert Leitch & Sons, Washington, D. C. All complete will cost \$14.00. If this pump be ordered the manufacturers should be requested to use the Agate mortar which is not so easily affected by the preparations as the rubber mortar. The Little Giant manufactured by Nixon Nozzle Co., Dayton Ohio, is better for large vineyard work, as it can be pulled by hand on its own wheels or it can be easily mounted in a cart or wagon and hauled over the vineyard. Two hose can be attached to it which enable it to spray two rows at once. Cost with sixteen feet hose and two nozzles \$35.00.

