

COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

BULLETIN No. 128.

# GRAPE CULTURE,

BY

PROF. GEO. C. BUTZ,  
*State College, Pa.*



*PUBLISHED BY DIRECTION OF THE SECRETARY.*

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1904.

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STATE PRINTER OF PENNSYLVANIA,  
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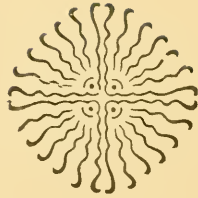
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## PREFACE.

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Commonwealth of Pennsylvania,  
Department of Agriculture,  
Harrisburg, August 11, 1904.

Among the recollections of my boyhood days there are none that afford me more pleasure than those that relate to rambles in the woods in search of the old time Fox and Pigeon Grapes that were then growing in abundance in the forests of my native county. I have always regarded the grape as one of our most delicious fruits, and I have never been able to understand why so many farmers make no attempt to grow them. I have had no experience in producing grapes for market; but among the first things planted on the farm upon which I began my career as a farmer nearly 40 years ago were a number of grape vines.

I am not sure that the conditions necessary to make grape growing on a large scale a success are found in all sections of the State, but I doubt whether any place can be found within our borders where a few grapes of excellent quality may not be grown. If, therefore, the Pennsylvania farmer does not wish to add the grape to the fruits he grows for market, why should he not cultivate a few of the plants in order that during the grape season, at least, a generous supply of this delicious fruit may be placed upon his own table.

The subject of grape culture should not only interest the farmer, but the dweller in the village or town who is fortunate enough to be the owner of his home, should have a few vines for the pleasure that is derived from the care of them as well as the fruit they yield. What adds more to the beauty of a village home than a tastefully trimmed and well-kept arbor made by training the vines of the grape over a properly shaped trellis? It is in the hope that all classes of our people to whom this bulletin may find its way, whether they be farmers, artisans or those engaged in professional work, may derive some benefit from it, that it is sent forth upon its mission.

N. B. CRITCHFIELD,  
Secretary of Agriculture.





## LETTER OF TRANSMITTAL.

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State College, August 1, 1904.

Hon. N. B. Critchfield, Secretary of Agriculture:

Sir: I have the honor to transmit herewith a report upon the prevailing practices in the best grape growing districts of Pennsylvania and neighboring states, where the varieties of American grapes are grown upon a commercial scale. There are many localities in Pennsylvania where excellent grapes could be grown, and in most cases grape culture is not engaged in because of a want of experience or knowledge of the requirements of the vine. The development of a grape district commonly originates with the pioneer experience of an intelligent farmer who wins success in his new enterprise, and is followed by others in his locality, who see how simple is the management of a vineyard, and how profitable is the culture of the grape. The systems of training and pruning should not confound the beginner, for a little close observaton of the nature and habits of the vine and an understanding of the principles of pruning will direct any good farmer to adopt a practice that will yield good results, even if he does not follow any established system.

It is the hope of the writer that this bulletin will serve to direct young grape growers in combating the diseases and insect enemies of the vineyard, and also induce many citizens of Pennsylvania to plant grapes either upon a commercial scale, or for a liberal home supply. There is no fruit that is more wholesome or that gives more satisfaction than the grape.

Very respectfully,

GEO. C. BUTZ.



## INTRODUCTION.

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The grape is one of the most satisfactory fruits to be grown upon the home plot of whatever dimensions, and the fruit grower in Pennsylvania will find a vineyard an excellent producer of income. A single vine near a house is a horticultural ornament and a source of much pleasure when the fruit is ripe. A grape arbor multiplies the advantages, and will yield fruit for jellies, jams and the table for a family. More to be desired is the small vineyard of 50 to 100 vines with varieties that ripen early and late, furnishing ripe fruit from the first of August to the first of December, of the several colors and flavors of our modern varieties.

The grape thrives in a variety of soils, so that no farm home and few others need to be deprived of this wholesome fruit. The notion that only experts can grow grapes is erroneous. Most of the grape growers began without experience or knowledge of grape culture and have found the work easy and the returns encouraging. This bulletin is prepared with a view to the needs and instruction of the beginner and amateur in grape culture as well as for the guidance of the commercial grower, who may find here some suggestions that will be helpful in the midst of the grape troubles that arise. The expert needs no assistance and the writer will be pleased to have his criticism of this publication.

There are many sections in Pennsylvania where almost ideal conditions for the culture of the grape exist and it awaits the decision of the owner to plant the vine. Along the Susquehanna River, the Allegheny and Monongahela rivers, and even smaller streams, profitable vineyards are maintained. When properly managed, a vineyard is much more profitable than an equal area of any farm crop.



## GRAPE CULTURE.

It is not commonly known that Pennsylvania is one of the prominent states in the production of grapes. In the value of its product, Pennsylvania stands fourth in the list of states, being led by California, New York and Ohio. In the census report for 1900, we find the following statistics on grape production in the nine principal states:

States.	Number of vines.	Pounds of grapes grown.	Value of product.
California, .....	90,686,458	721,433,400	\$5,622,825
New York, .....	2,636,216	247,698,056	2,763,711
Ohio, .....	13,772,800	79,173,873	932,745
Pennsylvania, .....	4,711,039	47,125,437	639,513
Michigan, .....	5,222,450	41,530,369	563,268
Illinois, .....	3,068,888	20,069,400	383,169
Indiana, .....	2,570,579	18,651,350	350,304
Kansas, .....	5,762,700	15,786,019	296,649
Missouri, .....	3,546,319	13,783,656	314,807

If these figures may be considered to represent average conditions from which we may judge the adaptability of a state to grape culture, then Pennsylvania should profit by a considerable increase in her acreage planted to vines. The largest yield of fruit per vine, slightly over 10 pounds, is shown for this State, while for California, New York and Michigan, it is 8 pounds, Illinois and Indiana 7 pounds, and Kansas and Missouri under 4 pounds.

Likewise, in regard to the price per pound for the fruit, Pennsylvania compares favorably with the five leading states; California averaging .8 cents per pound, New York 1.1 cents per pound, Michigan 1.2 cents per pound, Ohio 1.3 cents per pound and Pennsylvania 1.4 cents per pound.

Many sections of the State are well adapted to grape culture; but it is not within the power of a single grower to develop conditions in an isolated place so that he can successfully compete with the growers in the so-called grape belts, where, because of immense yields, the marketing and shipping facilities are the best, and the expense of hauling a crop is reduced to a minimum.

There is but one grape belt worthy of the name in Pennsylvania, and that is in Erie county, where it forms, in fact, the western end of the famous "Chautauqua Grape Belt." The vineyards in Erie county are mainly confined to a narrow strip of land, lying along the southern shore of Lake Erie. This strip is not over four miles wide, and extends in length from Harborcreek eastward to the New York State line, a distance of twelve miles. Northeast township, in Erie county, is crossed by this belt and has now about 4,000 acres in grapes. It is remarkable that of the 47,000,000 pounds of grapes grown in Pennsylvania, in 1899, nearly two-thirds, or 31,648,022 pounds, were produced in Erie county. This indicates the adaptability of the region to grape culture.

The readers of this bulletin will probably be interested to know the figures of the crop reported for the census of 1900 for each county of Pennsylvania. They are quoted in the following table showing the value of the product, number of vines, pounds of grapes and gallons of wine:

Counties.	Value of grapes and wine.	Number of vines.	Pounds of grapes.	Gallons of wine.
Adams, .....	\$5,056	15,670	213,067	1,659
Allegheny, .....	34,963	293,604	1,438,253	10,356
Armstrong, .....	3,144	12,362	139,283	434
Beaver, .....	12,152	44,387	989,433	1,719
Bedford, .....	5,459	13,711	286,631	1,560
Berks, .....	21,501	89,514	966,100	28,601
Blair, .....	7,450	53,313	312,050	2,271
Bradford, .....	5,487	18,855	230,925	589
Bucks, .....	8,529	40,074	374,852	6,766
Butler, .....	4,111	12,015	160,115	907
Cambria, .....	4,195	18,718	137,933	1,574
Cameron, .....	813	859	17,581	176
Carbon, .....	1,212	5,453	66,256	3,616
Centre, .....	2,716	9,585	99,041	262
Chester, .....	13,253	16,571	398,648	1,032
Clarion, .....	2,446	8,785	114,400	314
Clearfield, .....	3,629	16,859	143,080	307
Clinton, .....	2,903	8,765	82,071	176
Columbia, .....	2,951	9,452	120,975	1,225
Crawford, .....	6,132	61,592	525,050	1,837
Cumberland, .....	4,671	13,387	184,840	1,203
Dauphin, .....	10,056	33,356	383,553	3,232
Delaware, .....	5,717	43,026	169,265	831
Elk, .....	164	913	6,308	301
Erie, .....	292,548	3,193,268	31,618,022	50,945
Fayette, .....	5,525	31,814	244,156	3,115
Forest, .....	186	1,351	9,350	12
Franklin, .....	5,554	27,668	319,583	1,965

Counties.	Value of grapes and wine.	Number of vines.	Pounds of grapes.	Gallons of wine.
Fulton, .....	2,446	5,032	109,591	322
Greene, .....	3,283	13,598	160,100	124
Huntingdon, .....	4,590	15,789	171,444	331
Indiana, .....	2,945	10,862	102,273	199
Jefferson, .....	2,323	7,999	104,526	127
Juniata, .....	2,153	6,754	79,793	725
Lackawanna, .....	2,672	16,592	98,456	923
Lancaster, .....	24,960	59,846	1,299,657	11,636
Lawrence, .....	1,587	6,237	80,350	66
Lebanon, .....	3,892	13,077	187,543	1,607
Lehigh, .....	3,893	16,188	133,949	6,264
Luzerne, .....	2,267	7,656	138,438	1,090
Lycoming, .....	4,848	19,559	179,696	1,935
McKean, .....	39	149	1,560	31
Mercer, .....	5,176	16,429	239,810	295
Mifflin, .....	1,785	6,575	66,637	73
Monroe, .....	2,520	9,940	107,982	3,921
Montgomery, .....	16,920	23,129	566,133	3,708
Montour, .....	659	1,343	31,354	167
Northampton, .....	3,303	7,154	162,800	3,439
Northumberland, .....	4,669	20,442	213,072	2,005
Perry, .....	2,662	5,333	134,250	1,136
Philadelphia, .....	410	1,482	16,659	176
Pike, .....	1,444	2,042	45,212	863
Potter, .....	687	2,941	40,406	903
Schuylkill, .....	7,933	37,893	332,100	6,290
Snyder, .....	1,645	7,409	100,450	1,832
Somerset, .....	3,787	14,798	173,700	991
Sullivan, .....	471	1,692	22,443	78
Susquehanna, .....	2,533	8,173	116,528	113
Tioga, .....	1,707	6,708	62,885	119
Union, .....	1,342	5,963	83,488	479
Venango, .....	1,496	8,347	64,918	53
Warren, .....	935	825	14,504	89
Washington, .....	1,320	75,000	495,300	9,088
Wayne, .....	3,140	3,735	118,240	780
Westmoreland, .....	11,090	93,222	501,999	1,014
Wyoming, .....	1,425	6,597	70,400	125
York, .....	15,568	49,962	655,658	5,401
Totals for State, .....	\$629,518	4,711,029	47,125,437	194,610

## PROPAGATION.

The grape may be propagated in a variety of ways and with comparative ease. As a rule, the grape grower will prefer to buy his plants from the nurseryman. Nevertheless, there are often occasions when he will wish to propagate some vines from his own

plants, and then should know the various methods to choose the best one for his conditions. Sometimes a vacancy in a vineyard can be filled by layering from a neighboring vine; or a strong root system can be used by grafting a desirable variety upon it; or a vine of a choice variety is to be propagated to produce the largest number of plants by making cuttings of all the season's wood.

*Cuttings.*—The method by which the millions of grape vines are propagated, annually, by nurserymen is by means of cuttings made by ripened wood of the last season's growth. When the vines are pruned the "prunings" are used for making cuttings. This is most commonly done in the spring, in the month of March or early April in Pennsylvania, or the wood for cuttings may be taken in November, cut into proper lengths for cuttings and buried in sand or soil until spring. It is recommended to make cuttings in the fall in preference to spring, so that the wood may be protected during the winter, and the cutting be ready to develop roots as soon as the spring weather may influence root production. If the canes are exposed to severe cold and then are not cut until April, weaker plants are obtained than by fall cutting.

Only strong, well-ripened canes are taken and from these the slender, weak ends are discarded. Cuttings are commonly made from six to ten inches long, including two or three buds. (Figs. 1 and 2). The lower cut is made within one inch of the bud and the upper cut about two inches above the upper bud. The pruning shears, if sharp, will serve to make this cut, and will be more expeditious than a knife. To obtain very strong plants, mallet cuttings are made when it is possible to secure the proper wood. A mallet cutting is made from the lowest piece of a cane which has been cut with a section of the previous year's cane, as illustrated in Figure 3. It is evident that only one such cutting can be made from a single cane. It is sometimes recommended to peel or slit grape cuttings in various ways on the underground portion to give a greater callusing surface, but this is not practiced in commercial establishments.

Cuttings made in the fall are tied in bundles of 50 or 100 and buried in sand, moss or sawdust in a cellar where a temperature of about 30 degrees to 40 degrees F. prevails. Early in the spring they are planted in rows in ground where they can root and be cared for for one or two years. Most varieties of grapes will root freely in this manner, but a few of them, of which the Delaware is an example, do not root so easily. Cuttings of such varieties are sometimes buried in the fall in ground where the sun shines directly upon the surface. The cuttings are put in the ground, inverted, so that the butt ends are just under the surface. In this way the greater heat at the lower ends of the cuttings develops a good callus on each





Fig. 1. A three-eye cutting.



Fig. 2. A two-eye cutting.



Fig. 3. A mallet cutting.



Fig. 4. A one-eye cutting.



cutting, and upon the approach of cold weather they are covered with a heavy mulch of soil or are transferred to the cellar as already described. Another practice in rooting tender varieties is to put the cuttings in cold frames and have glass over them early in spring. These cuttings remain in the cold frames for a year and are then sold or transferred to the nursery row.

In the open ground a loose loamy soil should be chosen for the cutting bed. It should be free from stones and should be deeply prepared. If these conditions are secured, the cuttings taken from winter storage may be planted by pushing each one into the soil until only the upper bud is exposed. If the soil is so stiff and stony that the callus formed on the cuttings would be injured by thus pushing them into the ground, it is necessary to open a furrow to a line with a spade so that each cutting can be placed in position at the proper depth. The cuttings are put in about 6 or 8 inches apart in rows three and one-half feet apart to admit of cultivation with a horse. Cuttings are generally rooted enough at the end of the first year to be transplanted to the vineyard, but planters usually prefer two-year old vines. During the two years the cutting beds should be kept free from weeds and tilled with a cultivator.

*Single-eye Cuttings.*—Cuttings of grapes made with a single bud are frequently made in nursery practice with the rarer varieties. More plants can thus be made with a given amount of stock, and having the skill necessary for handling such cuttings, a fair percentage of one-eye cuttings are rooted. The foreign grapes, like the Black Hamburg, are commonly propagated in the north by this method.

Single-eye cuttings are made in the fall by taking pieces of the canes three or four inches long bearing the bud in the middle. Fig. 4. These cuttings are then buried in sand or moss and stored in a cool cellar the same as directed for the long cuttings. Early in February they are planted horizontally an inch deep in a sandy soil in a cool greenhouse. In about six weeks they will have developed root and branch enough to be potted off or be transplanted to a cold frame.

*Greenwood Cuttings.*—New varieties of grapes are sometimes propagated by forcing growth under glass and making cuttings of the growing canes. It may also be done by taking growing canes from the vineyard in the summer. The cuttings are made two buds long, leaving the upper leaf. They are best rooted in close frames with bottom heat. Careful attention must be given to ventilation and watering. In three or four weeks they will have rooted enough to be planted in pots. This method is not recommended to amateurs nor vineyardists, as it requires conditions which are not easily controlled outside of nurseries.

*Layers.*—For the amateur who wishes to propagate only a few plants from a favorite vine, or the grape grower who wishes to supply a few plants for vacancies, the method of hard wood layering is highly recommended. It consists simply in taking strong canes and laying them in small trenches in the ground under the vine, covering one or two buds with soil. The ground should be spaded and made loose before putting in the layers, as the formation of roots will be more rapid and abundant if the ground is loosened up. If not sufficient canes are available for the number of plants desired, the long canes may be bent down at two or three places, thus making as many plants. This is known as *serpentine layering*. The underground joints are held in place by means of forked branches. Layers of hard wood are put in in the fall or early spring, and in one year's time will be ready to be severed from the parent vine.

*Soft wood layers* are made with growing canes in the summer, in the same manner as the hard wood layers, and if made in July, will root enough by fall to be transplanted at that time or in the following spring. Soft wood layers do not make as strong plants as hard wood layers, hence are not made except in rare cases.

*Grafting*—In recent years the grape has been grafted very extensively, especially in Europe and other countries, where the European grape (*Vitis vinifera*) is grown, and the American insect, the Phylloxera, has been introduced. This insect is so disastrous upon the roots of the European grape, that it is necessary to propagate the vine by grafting upon roots of resistant species of grapes. Such species are *Vitis riparia*, our common wild Frost-grape, one of the parents of the Clinton grape, *Vitis rotundifolia*, or Southern Fox-grape, *Vitis rupestris*, or Sugar-grape of the West. The Clinton grape in Pennsylvania is commonly attacked by the phylloxera, but in spite of this fact it thrives and seems to suffer but little.

The grape is not a difficult subject to graft, but the operation must be carefully performed. On account of the flexible nature of the vine the grafting is usually performed below the surface of the ground. The *cleft-graft* is best suited to an established vine which is to be cut down and replaced by a better variety. The vine is cut off about two inches below the surface of the ground and pared smooth. The stub is then split with a large chisel, such as carpenters use, or with a regular grafting chisel. Sometimes a stub is so hard to split, that it is better to saw a slit to receive the scions. The scions are two buds in length. Well-ripened, short-joined wood should be taken. The lower end of a scion is cut wedge-shaped and two scions are placed in each stub. These should be inserted at a slight angle with the grain of the stub to make certain that the cambium lines of stock and scion cross each other. No wax is needed in this method of



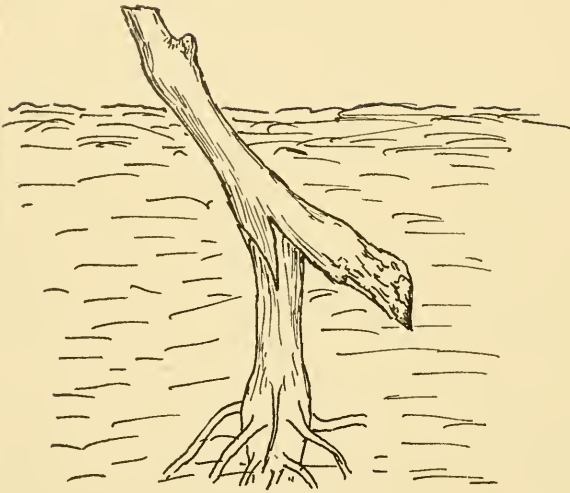


Fig. 5. Tongue graft.

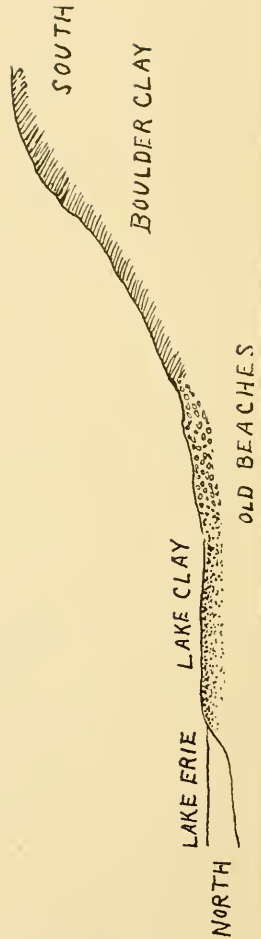


Fig. 6. Section of Chautauqua Grape Belt (after R. S. Tarr.)

grafting, but the union is entirely covered with ground. Only the top bud of the scion is exposed. Such grafts having the advantage of a strong established root system usually make a very large growth the first season, so that in the second year almost a full crop of fruit may be expected.

The season for grafting the grape is an extended one as it may be performed at any convenient time from October to May. Experience teaches, however, that the best results are obtained by grafting in early spring after the severe conditions of winter are past, and before the severe bleeding of the vines is likely to occur. The scions should be cut in the fall and stored until spring.

*Tongue Graft.*—In Europe and in California, the favorite style of grafting the grape is by a form of tongue graft. The stock and scion are nearly the same size in diameter. The stock is cut off below ground at an angle and is then split in a manner to receive the tongue of the scion, as shown in Figure 5. The scion is preferably the lower section of the season's cane where the joints are short and the pith slight. The tongue is made, not at the base as in ordinary tongue grafting, but at one side about one inch above the base. A thin piece of wood is removed from the side, then by a deeper cut a tongue is made of proper length to fit the stock, as shown in Figure 5. It is well to tie such grafts with narrow bands of cheap cloth to hold them securely so that the scion will not be disturbed when ground is replaced about the graft.

Other things being equal, the grafted grape-vine will live as long and produce fruit as well as a vine on its own roots. It will be clear to the reader that in Pennsylvania there is little occasion to propagate grapes by grafting.

*Seeds.*—The grape is easily grown from seed; but since the quality of the fruit depends upon the variety, and varieties do not "come true" from seed, it is evident that a choice variety cannot be multiplied by seeds. But new varieties are obtained by sowing seeds, therefore, to originate new varieties it is necessary to plant seeds, preferably, such as result from cross fertilization.

The seed may be taken from the berries when ripe and planted at once in a well-chosen and prepared seed bed, or they may be stratified, that is, mixed with a quantity of moist sand, placed in a cool cellar and kept until spring when they can be planted in the seed bed.

#### LOCATION.

The location of a single vine on home grounds is determined more by convenience than any other consideration, especially if it is to do double service as an ornament and a fruit supply. A trellis against

the house may be on the east, west or south side, preferably, the last named, where the strongest heat will make the sweetest fruit. The soil is, in such a case, necessarily a fixed condition. Where choice is possible, grape-vines should not be planted in wet or clayey soils, nor in shady places.

The commercial grower must select a site for a vineyard with much discrimination. If he will study the location of the wild grape of his vicinity he will get some good suggestions to guide him in his undertaking. The hillside exposures along streams are commonly the habitat of our wild grapes. The varieties grown in Pennsylvania are descendants of our native *Vitis Labrusca* or Northern Fox-grape. A warm southern or southeastern exposure is best suited to the grape. Level land is good where the soil and climatic conditions are most favorable. In the Chautauqua grape belt the vineyards are mainly on level land, but it must be remembered that the nature of the soil is ideal for the vine, and the influence of so great a body of water as Lake Erie upon the climate along its shores cannot be duplicated elsewhere in this State. On the slopes and hill-sides bordering our large streams, choice positions for vineyards may be found.

### SOILS.

The extensive vineyards in Erie county are planted upon three kinds of soils: First, a fine clay soil, which lies close to Lake Erie; second, a gravel of rounded pebbles, forming ridges or terraces one or two miles from the lake shore, and third, a boulder clay, being a fine clay, with many granite boulders. The clay is sometimes loamy and sometimes a veritable hardpan.

This region is well described by R. S. Tarr, Professor of Geology in Cornell University as follows:\*

"If we should make several north and south sections across the grape belt from the middle of the escarpment to the lake shore, they would be found to vary in details according to the location of the line, but to be quite the same in general features. The average condition would be as follows. See Fig. 6. Commencing on the hillside with a thin soil of clayey nature, and with an abundance of pebbles, and perhaps boulders, at the base of the hill, when at the elevation of about 250 feet above the lake, we come to a gravelly soil in which the pebbles are well rounded as if by water action. North of this there is a steep slope of twenty or thirty feet, at the base of which the soil becomes clayey; and this continues, usually for several hundred yards, when gravelly conditions are again encountered, somewhere in the vicinity of the main Buffalo and Erie turnpike. One

\*Bul. 109, Cornell Exp. Station, Ithaca, N. Y.



or two gravel terraces are found here; and at the base of the northernmost of these, clay again appears. Here, as in the case of the first gravel ridge, there are springs at the junction of the gravel and clay, so that, where not artificially drained, this place is continuously indicated by swampy conditions. From the top of the upper (southernmost) gravel ridge to the spring line at the base of the lowest, the descent is about 90 feet, and the distance anywhere between 200 or 300 yards and a mile, or even more, though usually not far from a quarter of a mile.

"From this point lakeward, a distance of one or two, and in some places even three miles, the plain is somewhat irregular, with a general descent toward the lake, which is some 150 to 160 feet below the gravel ridges. The soil is usually a clay, though it is often of a sandy nature. The immediate shore line is commonly a bluff, either of shale or of clay, though at times it is in the form of a beach, without any well-developed bluffs."

It will be seen that the soil of this noted grape region is absolutely a "made soil," that is one deposited by the movement of water. While vineyards are planted all the way from the lake shore to the top of the hill at the south four or five miles away, the most profitable and extensive vineyards are upon the gravel ridges forming the middle band of this region. The gravel is a very loose open soil, warming quickly under the influence of the sun. It is well drained, but is supplied with moisture at such a depth that grape roots can easily reach the water. Such conditions are ideal for grapes and wherever such a character of soil can be found, even though in limited areas, it will be found a suitable location for a vineyard. Upon gravelly soils the grape makes short-jointed canes, and in general, less rampant growth, which insures earlier ripening of the fruit, and in fact sweeter and better fruit than is obtained in clayey soils. The objection to clay soils is in their being cold, or too rich in nitrogen, or not well drained.

Soil which naturally looks poor because nothing but mulleins and dewberries grow upon it, should not be overlooked when locating a vineyard, for it is likely to be the very best piece of land for the grape.

Shale soils, if not too "raw" or fresh, will be very satisfactory for grapes, and sandy soils, such as are chosen for peaches, may also be used with success. Soils which are generally considered poor by farmers are so, largely, because of a lack of nitrogen. Such a condition is favorable to the grape and especially if there is a good supply of phosphoric acid and potash present.

#### PREPARATION OF THE SOIL.

If virgin soil is to be prepared for the vineyard, it should be cleared of all trees, stumps and stones that are likely to interfere with culti-

vation. If a very steep hillside is to be used it may be necessary to terrace it in order to work among the vines and prevent the loose soil being washed away from the roots. It was once thought that only hillsides should be used for grapes, perhaps, because in Germany many remarkable vineyards are planted on steep hillsides. The cost of growing this fruit in such places is greater than upon easy slopes, hence, for the commercial fruit grower, the steep hillsides should be avoided.

The soil should be deeply pulverized. The grape has a peculiar root system. The roots are long and slender, they penetrate the soil at great distances in search of food and moisture, and to aid them in this important work the soil should be loose and friable. Deep plowing before planting is highly recommended. Some writers recommend sub-soiling, but this should not be necessary. A soil that would require sub-soiling is not suited for the grape. It is very evident that gravelly soil could not be much improved by sub-soiling, and a compact soil would soon fall back into the same compact condition after sub-soiling and the vineyard would suffer because of an uncongenial soil.

Though vines are planted 8 or 9 feet apart, the entire area to be planted must be plowed. Such preparation will insure a better growth of vines than could be expected by plowing only narrow strips or digging small holes. The roots rapidly extend themselves over the entire area. In the Erie county district sod land is customarily plowed in lands 9 feet wide, leaving dead furrows at the same distance, and being about 9 inches deep, these dead furrows are used to plant the vines in. The sod will rot while the plants are becoming established. Stubble land is plowed entirely and prepared for planting by running a double furrow at the proper interval of space.

#### SELECTION OF VINES FOR PLANTING.

The age at which grape-vines are planted in vineyards is one or two years. No. 1 one-year old vines are in excellent condition for planting, bearing a strong cane of cutting bed growth and a goodly supply of roots. Very often, however, one-year old plants are weak, particularly if the weather was not favorable to their growth in the cutting bed. In such cases two-year old plants should be selected. Nurserymen usually recommend two-year old plants, but specialists in grape culture often handle the grape at one year old.

Single plants of standard varieties sell at 10 to 20 cents each, or \$1.00 to \$2.00 per dozen; but for extensive planting, they should be purchased in quantity at from \$5.00 to \$10.00 per hundred, according to the variety and vigor of the plants. No weakly or stunted plants should be planted.

## PLANTING.

In this State the best time for planting grapes is in the spring. As soon as the ground can be prepared, planting may begin. It is best to have it completed by the last of May. If it is possible to select cloudy weather for the planting it is of course wise to do so, but in extensive operations such selection is not possible.

The vines are received from the nursery just as they are taken up, consequently some pruning is necessary before they are planted. The last season's wood is to be cut back to the second or third bud. This seems to the beginner like a great sacrifice of wood, but experience has shown the wisdom of the practice. The roots, if very long, may be shortened to one foot, and such as proceed from joints above the base may be removed entirely. Such pruning will greatly facilitate planting, and the vines will be better able to establish themselves in their new conditions.

A peck of good soil drawn over the roots, if the planting is being done in open furrows, and made firm by tramping over it, will keep the plants in place until more ground can be thrown to the vines by plowing or harrowing.

For Concords and Niagaras the distance between plants is 8 feet with 9 feet between the rows. If varieties, like the Delaware, making less wood are planted, a less distance between the plants would suffice, but the distances named prevail in nearly all the commercial vineyards. Eight feet by 8 feet and 9 feet by 9 feet are distances frequently used also.

The number of vines per acre at 8 ft. x 8 ft. is 680.

The number of vines per acre at 8 ft. x 9 ft. is 605.

The number of vines per acre at 9 ft. x 9 ft. is 537.

## CULTIVATION.

The first two years in the life of a vineyard constitute a critical period because there is no financial return for the labor required and just as much tillage must be given then as in any subsequent year. Everything that will insure the uniform and rapid growth of the vines must be promptly attended to. Frequent cultivation to consume the moisture and frequent hoeing out of weeds to remove competition will demand some labor, but this labor will be amply repaid by the future success of the vineyard.

During the first year, but not longer, a hoed crop may be grown between the vines. Cabbage, tomatoes or even strawberries have been grown in this way, but it is not always convenient to handle another crop in the vineyard. It is the opinion of experienced men that crops in vineyards at any time are grown at a loss to the vines.

Without a second crop, the ground may be worked both ways and hand working is greatly reduced.

During the second year of the vineyard the work is mainly a repetition of that of the first season. In the spring the first pruning of the vines is called for. The canes made in the first summer are cut back to two or three joints. The weak canes are removed entirely, thus leaving but one to three spurs to a plant according to the strength or vigor of it. Any vacancies occurring at this season are to be supplied with new plants.

In the spring of the third year it is necessary to put up the trellis. The vines are now large enough to need supports, and the style of trellis to be used must be determined. This matter is considered under the proper head later on. We confine our thought now to the cultivation of the ground. Regarding the vineyard as being well established, the annual tillage consists of the following operations: After the pruning is completed and the prunings disposed of, the ground in April or May is plowed. For this some vineyardists use a one-horse plow, others a two-horse plow and still others prefer a gang plow of four shares. At this plowing the ground is thrown from the vines. At the last working in August the plow is again used throwing the ground toward the vines. This affords some winter protection. After the plowing in spring the surface is smoothed with a spring toothed harrow. The strip of ground in the row which cannot be broken with the plow is cut out with a horse-hoe. Two forms of this implement are in use, the Springfield grape-hoe and the Morgan grape-hoe. The former has a pair of wheels and the hoe articulates at the axle; the operator lifts the hoe into place by means of plow handles. The latter is more simple in construction. It has a small disk wheel which is operated by a handle and serves as a rudder to guide the hoe where it is wanted.

After the general breaking of the ground in the spring with the plow and harrow, the cultivator is used frequently to keep the surface loose and kill the weeds until August. Many of the best vineyardists cultivate every ten days or two weeks. In August, as already stated, the ground is plowed, throwing the furrow toward the vines.

In practice, little is done with cover crops to improve the land. Crimson clover has been used experimentally and proved very satisfactory. If this is sown late in July with the last working, a fairly good stand may be made. It would be injured somewhat by the tramping of grape pickers in October, but the gain in soil improvement is ample reward for the expense of the seed and labor.

Mr. Z. Rogers, a successful vineyardist of North East, Pa., with forty years' experience has, in recent years, concluded his summer

tillage with the cultivator in August, leaving a comparatively even bed of ground. Over this springs up a low green mat of chickweeds, sandworts and veronicas which make a carpet that is pleasant for pickers to travel over in October.

The Southern cow pea, if sown not later than the first of August, will make enough growth to afford a substantial winter cover for the ground and furnish a good quantity of vegetable matter to be plowed under in the spring to contribute humus and nitrogen to the soil.

If cover crops cannot be sown before the middle of August it is best to use such late growing plants as rape or turnips. Rye may be sown in September and furnish a green carpet for pickers in October.

#### FERTILIZERS.

The use of fertilizers in vineyards has not yet been reduced to a uniform practice. Until quite recently no fertilizer was used except barnyard manure in greater or less quantities, and then not every year. Some vineyards, even 20 years old, have never received any fertilizer. We know now that barnyard manure is essentially a nitrogenous fertilizer and as such stimulates the growth of vine and foliage. This may often be desirable, particularly if a soil poor in humus has been used for the vineyard, but when a soil has been chosen that produces vigorous vines it must be apparent that an application of barnyard manure would be unwise. We also know that the essential plant food for the development of fruit is potash and, consequently, the intelligent grape growers are using largely of this element, buying wood ashes, kainit, muriate of potash and sulphate of potash. It is also known that the phosphorus compounds are essential to the general nutrition of all plants, and that phosphorus is found in greater quantities in seeds than in any other part of plants. As the development of fruit is dependent upon the development of its seed, it is clear that this plant food should be supplied, when it is manifest that it is lacking in the vineyard soil. To supply this the vineyardist buys bone meal or rock phosphates.

The quantity of fertilizers used has been with considerable range. In one vineyard no manure has been used in twenty years, in another a wheelbarrowfull was placed about each vine annually. In one vineyard 200 pounds of muriate of potash per acre was applied once in several years, in another, 800 pounds of the same fertilizer was applied to each acre annually.

Every agriculturist and horticulturist who has to solve the problem of how much fertilizer is profitable to apply to a crop, soon learns that while a heavy application may produce a larger crop than a light application, yet the limit of better financial returns is reached long

before the limit of increased yield. Therefore, the question is one of experiment in each vineyard because of the variation in soils and the vineyardist must make his own determinations. He should begin, supposing he has average conditions, and apply various quantities until satisfactory results are obtained. Dr. L. L. Van Slyke\* recommends for the grape, as an annual application per acre, the following composition of a complete fertilizer:

Nitrogen, .....	2 per cent.
Available phosphoric acid, .....	8 per cent.
Potash, .....	12 per cent.

To provide this, the vineyardist may use 50 to 100 pounds of nitrate of soda, 400 to 800 pounds of dissolved South Carolina rock and 200 to 400 pounds of muriate of potash. If it is more convenient, the nitrogen may be supplied in barnyard manure, or crimson clover may be grown between the rows and turned under. The potash may be supplied in wood ashes if they can be obtained for less money than the muriate, or it may be preferred to use kainit. Kainit is now commonly used in Erie county by throwing a quart of the salt about the trunk of the vine, with the belief that it will drive away the "root-worm," and kill weeds. Even if this be true, it is not the most approved method of applying such a fertilizer. The roots which feed the vine ramify and penetrate the soil to great distances and cannot take up nourishment that is concentrated at the base of the vine. The kainit, like all other fertilizers, should be sown broadcast over the vineyard soil to give best results and the weeds should be hoed out in the old-fashioned way and the "root-worms" should be treated as directed in the subsequent discussion of that insect.

#### TRELLIS.

In the modern commercial vineyard the grape trellis is essentially a wire fence, consisting of substantial chestnut posts placed 27 feet apart and two or three wires of No. 9 or No. 10 guage. The posts are from six to eight feet long. The longer posts will afford a higher trellis, and hence give more area for the canes to spread over, a condition much to be desired for such vigorous varieties as the Concord and Niagara. The posts should be somewhat heavier than those commonly used for wire fences, for a vineyard's life may endure 50 years and the trellis should not require renewal too often. If chestnut posts cannot be obtained, other durable timbers like cedar, locust or oak might be used. The cost of such posts in quantities should not exceed one cent per lineal foot. In such soil as there is in the Chautauqua grape belt, the posts for trellises are usually driven into the ground by sharpening the base

\*Bul. 55 Dept. of Agr., Harrisburg, Pa.



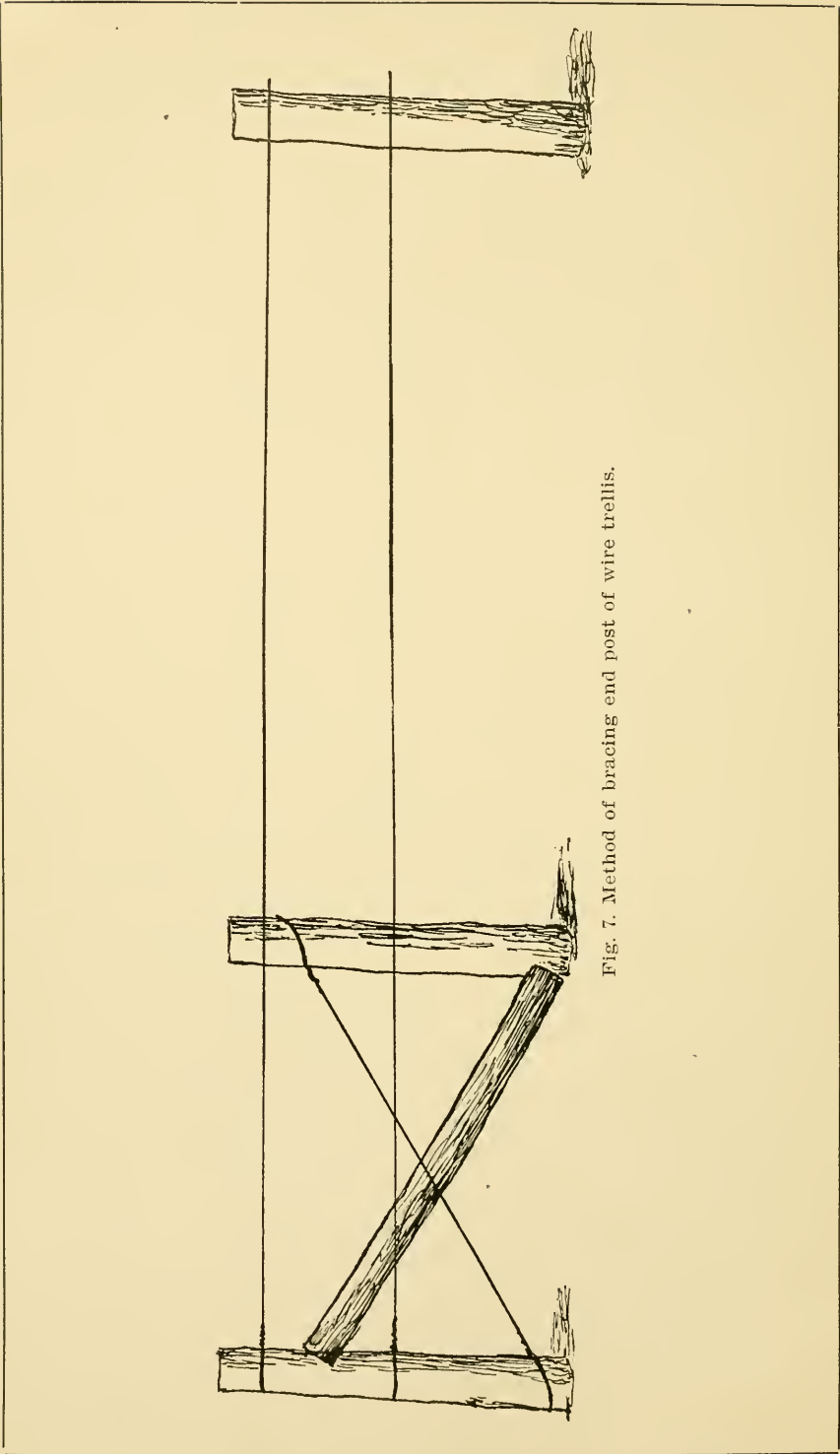


Fig. 7. Method of bracing end post of wire trellis.



and using a heavy maul. In general, throughout Pennsylvania, the posts must be set by digging holes with the spade. The end posts, particularly, should be set with the spade, at least two feet deep, interior posts at least eighteen inches deep. It should be remembered, that when a trellis is covered with fruit and foliage and the ground is soft with rains, a windstorm could do serious damage to a trellis that is not securely planted in the ground. The end posts are braced with a stiff timber, as shown in Figure 7.

When vines are planted 9 feet apart, the posts are put in 27 feet apart, making one to every three vines. If vines are but 8 feet apart, the posts are 24 feet apart. In practice, it is found convenient to have a continuous trellis not longer than 50 vines, or 450 feet, then 12 rows make an acre, there being, strictly speaking, 605 vines to the acre when planted 8x9 feet. In all vineyards of 25 acres and over, an alley across the rows at intervals of 50 vines is convenient for harvesting the crop and for removing the grape trimmings after pruning.

The wires are strung on the windward side of the posts. When three wires are used, the top one is usually No. 9 or 10 and a lighter guage for the lower wires usually, No. 12. When only two wires are used, both are No. 9 or No. 10.

The following figures show the weights of several sizes of iron wire:

Number.	Diameter in inches.	Weight of 100 feet.	Feet in 2,000 pounds.
9, .....	.148	5.80	33,483
10, .....	.135	4.83	41,408
11, .....	.120	3.82	52,356
12, .....	.105	2.92	68,493

Ordinary wire fence staples may be used to fasten grape wires unless the posts are of a soft wood when longer staples should be used. The bottom wire is placed about 30 inches above ground and is never moved, the second wire is at first placed about two feet above the lower wire, and may be raised to three feet when the vines are strong enough to warrant it. The wires are fastened to the end post by passing around the post and holding the end with a staple or it may be twisted around the wire. The wires should be drawn taut enough that they will not sag with a weight of fruit. The staples on the line posts are not driven to sink the wire into the wood.

but allow enough play for the wires to be tightened when necessary. If some device could be devised to relieve the tension owing to the contraction of the wire in winter, and take up the slack as warm weather expands the wire, the annual work of tightening wires would not be called for. As a matter of fact, however, the posts need straightening and firming and this is done also each spring.

*All-wood Trellis.*—Before the days of wire fences, the vineyard trellis was made of wooden slats and in some cases even yet it may be found convenient to make such a trellis. It calls for more frequent repair, however, and on this account is much more expensive than the wire trellis. The posts are set 8 feet apart. The slats are 16 feet long, the lower and upper pieces are 3 inches wide and the middle one or two pieces may be 2 inches wide, cut from inch boards. Another form suitable to an upright system of training is to use only the two three-inch slats and tack strong plastering lath perpendicularly across the trellis at intervals of a foot.

*Posts.*—In many parts of Pennsylvania where grapes are grown, particularly in small vineyards, posts or strong stakes are employed as supports for the vines. Where the land is very hilly and uneven it is probably the most satisfactory form of support.

The stakes are 8 or 9 feet long of chestnut or oak and split to the thickness of a fence rail. The splinters should be removed with a carpenter's drawing knife and the base should be sharpened to a slender point to make driving easy. Such a stake is driven close to each vine.

#### TRAINING.

The training of the grape is for the purpose of developing the best quality of fruit, with the greatest convenience. The vine naturally runs over trees high in the air. Fruit is borne by the native vines, but it is not of the best quality because of the lack of light and air, and it would be very inconvenient to harvest a crop from such vines. Hence, the trellis and the vineyard afford better conditions for the cultivation of the grape. Among the vineyardists who cultivate the American grape, there are many systems of training. Some of them guarded as great secrets without which no success can be attained in grape culture. Advocates of different systems argue with each other in conventions, citing experiences that discredit every system but their own. The important matter is to so dispose the vine over the portion of trellis allotted to it that there shall be freedom of air and light about all parts of it.

There are three systems of training that are most prevalent in the Eastern states. These are known as the *Kniffen system*, the *High renewal system* and the *Chautauqua system*. Each of these will be



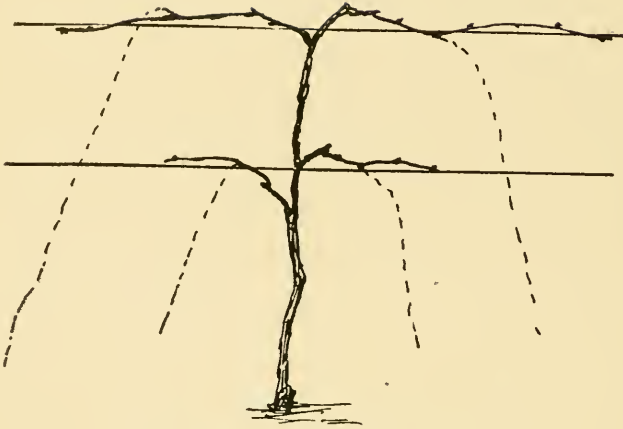


Fig. 8. The four-arm Kniffen system.

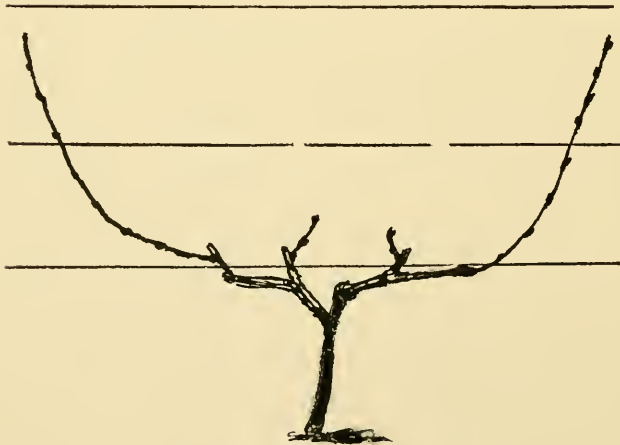


Fig. 9. High renewal system.

briefly discussed and the reader is advised to choose the one which best suits his own mind as he would choose a style of hat.

*The Kniffen System.*—This system is the popular style of training grapes in the vineyards of the Hudson River Valley. It takes its name from the originator, William Kniffen, who, in the middle of the last century, had some vines growing near an apple tree, a limb of which was broken by accident so that a portion of a vine was crushed. His vines were undoubtedly trained by the old horizontal arm system with upright canes, but when the fruit ripened he discovered that the best fruit was on the portion of vine that was crushed by the accident. He reasoned from this that drooping canes bear better fruit than upright canes, and subsequently developed the system which bears his name.

A single strong cane is carried to the upper wire of the trellis, from there two side canes are carried along the wire, one in each direction. In the same manner side canes are laid along the lower wire. The arms on the upper wire are longer than those on the lower wire for the strength of the vine goes mainly to the top. The bearing canes from these arms are allowed to droop as they will without tying.

At the subsequent pruning all the wood is cut away except one strong young cane at each of the four spurs on the upright. These canes are shortened to the proper length and tied to their respective wires. In this way the arms are renewed each year and only the upright cane is permanent. The dotted lines in Figure 8, show the position of the fruit bearing canes in the summer. Of course when these canes are but a foot long they are upright, but they droop as they lengthen and the fruit gets heavy.

Strong growing varieties of grape are well suited to this system of training, but the weaker varieties, like the Delaware, do better with shorter upright permanent canes.

*The High Renewal System.*—In the lake region of Western New York the favorite style of training is that known as the High Renewal System. In this system the first cane of the young plant is headed at a height somewhere between 20 and 30 inches, and two arms are subsequently laid upon the first wire from this point. The higher point is better than the lower because the vine will the better escape injury from the implements used in cultivation. At the next pruning the arms are cut to spurs of six or eight buds. The canes from these buds will be tied to the second wire when they are long enough. Some of them may reach the third wire before the end of the season. When this vine is pruned, after the foliage has dropped, the side arms are cut away almost to the fork with all their growth of new canes except the strongest near the base of each arm. See Figure 9. When the tying is done the following spring, these chosen

canes are tied to the lower wire making the new arms for the coming season. Thus each year the arms are renewed and it is this practice which gives the system its name.

*The Chautauqua System.*—This system is commonly practiced in Erie county, Pennsylvania, and, in fact, throughout the Chautauqua grape belt. It consists of a trunk tied to the first wire (which is placed about 30 inches from the ground), and two permanent arms tied horizontally. From these, four to eight canes of a season's growth are tied upright to the upper wire. These canes are headed off at the height of the trellis. Each will have about five or six good buds, making an average of forty buds on a very strong vine. Such a vine of the Concord grape will bear from twenty to thirty pounds of fruit. Each year the pruning consist in cutting away all the wood above the permanent arms except the usual number of fresh canes for uprights as shown in Figure 10.

These three systems of training may be found in the same vineyards, especially where many varieties of grapes are grown; but more commonly a particular system is adopted and followed as closely as the condition of the vines will permit. There are other systems worthy of consideration, but space cannot be given here. One other is frequently met with and called

*The Umbrella System.*—This is essentially a two-cane Kniffen System, in which the young canes taken from the top of the upright trunk near the top wire are carried downward and tied to the lower wire in the position of two ribs of an umbrella, as shown in Figure 11.

*Posts.*—Where posts are used for supports, various methods of pruning are practiced. Commonly, a permanent trunk is tied to the stake, headed variously from three to five feet in height. This trunk supports spurs from which the fruit bearing canes proceed. The annual pruning consists in cutting away all the last season's growth to short spurs one, two or three buds long. Well-developed vines may support ten such spurs of two or three buds each.

#### PRUNING.

The pruning of grapes has been incidentally treated under systems of training. The subject, however, deserves more specific treatment. As to the time for pruning, it may be said, that the operation may be safely performed at any time after the leaves have fallen until the sap begins to flow freely in the spring. The injury occasioned by the "bleeding" of the vine when it is pruned late is much less than is commonly feared. Nevertheless, in most cases, the pruning should be done in the late fall to leave the springtime open for more timely labor. No matter what system of training is followed, all weak wood must be removed and the remainder adjusted to the ideal form of the

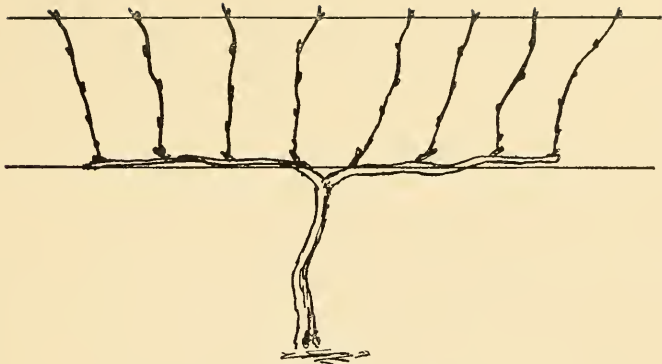


Fig 10. Chautauqua upright system.

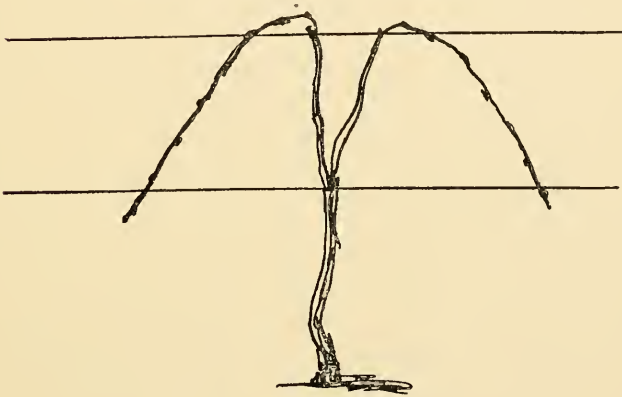


Fig. 11. Umbrella system.

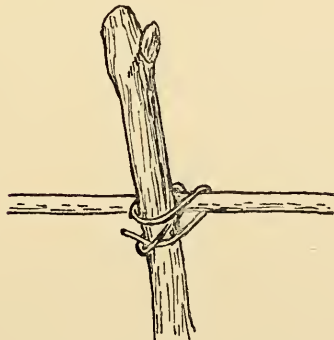


Fig. 12. Method of tying with wire.





system as can best be done. Sometimes "spurs" become weak and sickly and should be removed entirely. When it is possible, new spurs of young wood are left as near the old position as can be.

Standing before a vine, the expert pruner will decide in his mind from the present vigor of the vine just how many buds can be profitably supported the next season. After cutting away the very weak canes, a selection is made from among the remaining canes of those best suited to his ideal of a properly pruned vine. These are cut to their proper length and all superfluous canes are cut away. It is not safe to use untrained hands for this work, but one expert may supervise the work of a half-dozen unskilled workmen by directing them from time to time and keeping a close watch on the work they do.

The prunings or grape brush are taken to open places where they can be burned. It is something of a task to remove the brush from a large vineyard, and various ways have been thought of to do it. The common practice now is to take a pole 10 or 12 feet long, made of a sapling 4 inches in diameter at the bottom and 2½ inches at the top. A hole one inch in diameter through the pole at a point four feet from the butt end admits a strong rope 8 feet long to which a horse is attached. A man holding the small end of the pole guides the butt end of the pole along the ground under the brush and with the draft of the horse easily draws the brush to the end of the rows. From here it is hauled to brush heaps and burned.

*Summer Pruning.*—When the vigorous growing varieties of grape are planted in rich soil, they are likely to make such a rampant growth that the fruit suffers from the excessive amount of foliage and the drain upon the food supply. In such cases it is wise to practice summer pruning. In July or early August, the excessively long canes are cut off at two or three joints above the last bunch of grapes. This tends to throw more food into the berries and in permitting the light and air to penetrate to the fruit, the latter becomes better developed with finer quality. In Erie county, summer pruning was formerly practiced to a limited extent, but it was abandoned because it seemed unnecessary in the very gravelly soils where excessive growth is seldom met with. In clayey loams having rich supply of nitrogen, Concords and Niagaras would make canes 10 to 20 feet long. Such excessive growth should be checked by root pruning as well as by summer pruning of the tops. The former is accomplished by digging trenches on either side of the trellis about two feet from the vines and deep enough to cut off the roots that are encountered.

Pruning is looked upon by the novice as a harsh and unnatural treatment of the vine. It should be remembered that the purpose

of cutting away any portion of a plant is to improve the remaining portion. By pruning the grape the vine is kept within the bounds of the trellis, and consequently cultivation is facilitated; the plant is prevented from overbearing and thus large quantities of small and inferior fruit are avoided. A vineyard can be quickly ruined by neglecting to prune or to prune without an intelligent understanding of the principles of pruning.

After pruning, the vines are permitted to swing free from the wires during the winter in the belief that they suffer less from the winter weather. Often vineyardists will cut the strings which tie up the permanent arms.

*Tying.*—The tying of the grape is performed in the spring. In vineyard sections of the country, women, girls and boys are trained to do this work, for which they are paid \$1.00 per day. The material used may be raffia, osier willow, green rye straw or the dry straw soaked in water, bass bark, corn husks, wool twine or small wire about the thickness of that used in wire hairpins. The permanent parts of the vines are somewhat loosely tied with strong strings or willows and the annual canes are most expeditiously fastened with No. 18 annealed iron wire. The annealed wire is soft and will bend easily. It is cut in lengths of 4 inches. The operator works from the opposite side of the trellis from the vine and with a few turns of the wire quickly fasten the cane, as shown in Fig. 12.

*Suckering.*—In the established vineyard the old vines each spring send up suckers from the roots. These must be removed, as they can form no part in our systems of pruning. They are easily removed while the tissue is soft and the work is generally done in June by women, who are paid \$1.00 per day for such work, when a man's wages are \$1.50 per day. When the vine on the trellis is becoming weak because of some local trouble, as an injured trunk or cankerous old wood, or because of winter-killing it is a good practice to leave a strong, vigorous sucker which shall become the plant at the next pruning, and the old, weak top will be entirely cut away. Of course, if there is a general debility in the vineyard, or a section of it, it should be considered a mark of insufficient plant food and be overcome by the use of fertilizers upon the land.

#### RINGING.

Ringling is an operation performed on grape-vines, as well as on other fruit plants, for the purpose of developing larger and better fruit, and also to cause earlier ripening. It consists in removing a ring of bark about an inch wide from the bearing branch when the fruit is about one-third grown. The latter part of June is the time when the bark can be easily separated from the wood. This

process of enlarging fruits depends upon the fact that the raw materials of plant food gathered by the roots of a plant pass upward through the last formed wood tissue (sap-wood). This is assimilated by the foliage at the top of the plant and sent downward through the branches in the inner bark tissues to be used where needed for growth. The ring of bark being removed, a larger supply of food is forced into the fruit than is otherwise obtained and, consequently, the berries, in the case of the grape, are larger, the bunches heavier and maturing earlier, they ripen one or two weeks earlier than the ordinary time for the variety.

In removing the bark care must be exercised not to injure the wood or the upward flow of plant food is obstructed and the beneficial effects of ringing is lost. The width of the bark removed should be great enough so that the healing process that immediately takes place will not bridge over the wound within the season. The branches which have been thus girdled are greatly weakened by the operation, and when the fruit is harvested such branches are cut away; that is to say, at the subsequent pruning of the vine, where any one of the renewal systems of pruning is practiced, no loss is experienced. In the Kniffen system, for instance, the arms on the upper wire may be ringed at about a middle point. This will afford sufficient foliage under the girdle to keep the vine in health and produce strong canes to renew the arms.

Ringing is an operation that is not practiced on a commercial scale, but vineyardists who have a fine table trade or who wish to grow particularly fine fruit for exhibition purposes commonly adopt this method.

While the fruit above the girdle is greatly enlarged, that which hangs below the girdle is correspondingly smaller. It should be removed at time of ringing for the best results.

In an experiment conducted by the Experiment Station at Geneva, N. Y.,\* several varieties of grapes were ringed with different results. Concord fruit was greatly enlarged and ripened seventeen days earlier. Delaware fruit was not affected in size, was inferior in quality, but ripened nine days earlier. Empire State fruit was greatly enlarged and ripened 21 days earlier. Moore fruit was but little affected in size or quality and not at all in time of maturing. Niagara fruit was somewhat enlarged and ripened fourteen days earlier. Worden fruit was but slightly affected either in size or earliness.

Ringing should not be practiced upon the same vines year after year because of the loss of vitality occasioned by it. The effect of the operation upon the fruit in the second year is greatly reduced, so that it is better to ring the same vines only once in two years.

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\*Bul. 151, Exp. Station, Geneva, N. Y.

## BAGGING.

It has long been a practice among amateur grape growers, to enclose the clusters of grapes in paper sacks for the purpose of protecting the fruit against insect attack and to preserve the bloom and aroma of the fruit. The improvement was so marked that many commercial vineyardists annually bag a large quantity of clusters, for which, when ripe, they obtain a special price that amply repays the extra labor and expense.

Sacks of a poor thin paper should not be used, as they are likely to go to pieces when exposed to the weather. The 2-pound manilla sack, holding a quart, is the right size to use. Such sacks can be purchased in small quantities from a grocery or in large quantities at a very low cost from dealers in such goods. To be most effectual, bagging must be done as soon as the fruit is set, which will be from the middle to the last of June, according to the locality and season. The bag, fully inflated, is drawn over the small cluster and drawn together about the stem and tied with a string or wire, or, better still, it is drawn up over the cane bearing the cluster and turned over and pinned. Thus protected, the berries develop free from fungus attack or insect injuries. This method serves also to prevent chickens picking at the fruit when they have access to the vines.

Bagged grapes may be left on the vines longer than unprotected fruit without fear of injury from early frosts, or they may be cut and laid away in a cool place without removing the bags, to be used after the other fruit has been disposed of, for the bagged fruit has better keeping qualities as well as better size, color, flavor and sweetness.

## SPRAYING.

Under the heading of Fungus Diseases and Insect Enemies are described the natural enemies of grape culture. One or more of these are certain to attack any vineyard. Many of them may be present every season, but no serious damage is done and no notice is taken of them. But sooner or later the conditions are favorable for the rapid spread and development of a fungus disease or insect pest and the entire crop of fruit is ruined or the vines are so weakened that several years are required for them to regain their former vigor. The vineyardist was unprepared to meet such conditions. The grape growers in Erie county, in 1902, were in such a position when the Black Rot struck the famous Chautauqua grape belt for the first time with serious results. For several years it had been demonstrated that spraying with Bordeaux mixture was an effectual remedy for Black Rot in vineyards, but none of the grape growers

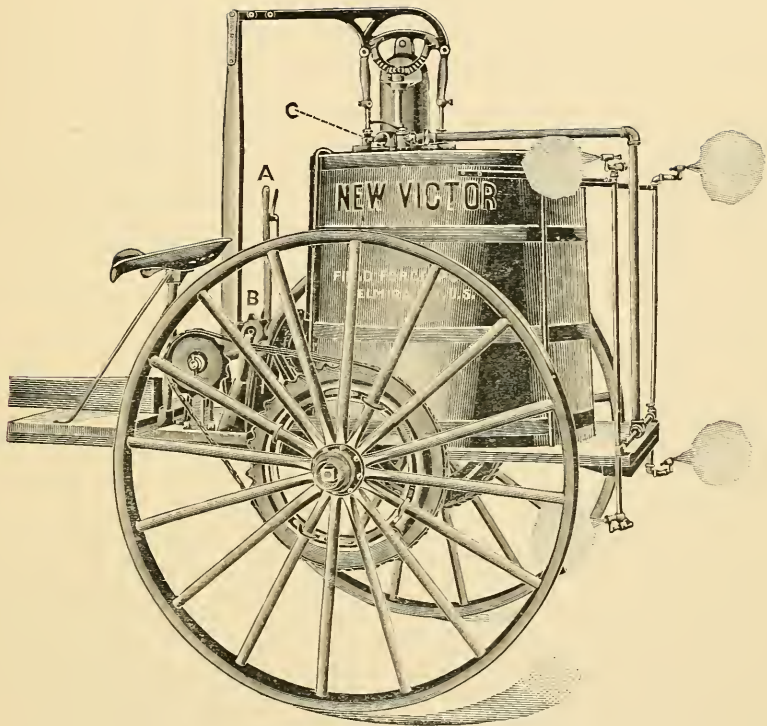


Fig. 13.—The New Victor Sprayer. Manufactured by Fields Force Pump Co., Elmira, N. Y.,







Fig. 14.—The Pierce-Loop Sprayer for vineyards or orchards.



had spraying apparatus and few knew much about spraying. After the demonstrations and experience of 1903, with the excellent results of spraying in a few vineyards, the neighbors were convinced of the value of this modern operation in successful fruit culture. One grape grower showed figures to prove that his spraying cost him \$6 per acre and saved him \$30 per acre. Another having extensive fruit interests, declared that he was benefited financially and otherwise to the extent of \$3,000.

*Sprayer.*—Each fruit grower should study the different types of sprayers and select the one which is best suited to his purpose. The knapsack sprayer finds but little use in commercial fruit plantations. The barrel pump, mounted on a sled, is not as expensive as a geared sprayer, and much more thorough work can be done with the former. A geared sprayer, like the one illustrated in Fig. 13, known as the "New Victor," requires but one man—the driver—to operate it, but the four fixed nozzles shown in the illustration do not insure effectual spraying. It would be better to assemble all the nozzles in a cluster of four to eight and connect it to the sprayer with a twelve-foot length of three-quarter inch hose and put another man in charge of it, to see that the fruit and foliage in the interior of the mass of vines as well as the exterior receives the spray. Any portion of the green vine or fruit that is not covered by a film of the fungicide is liable to the attack of a fungus disease. Operated in this way by two men the New Victor sprayer will do thorough work at the rate of ten acres per day. The list price of this machine is \$70.00, including the cart and all fixtures. The tank holds 100 gallons.

Automatic sprayers are being constructed with good practical ideas, and should be considered when making a selection for the commercial vineyard. The Pierce-Loop sprayer, Fig. 14, manufactured by the Pierce-Loop Co., of North East, Pa., is one of this style, which has been in use for several years and has given great satisfaction. The sprayer consists essentially of two tanks of fifty-two gallons capacity each, mounted on a two-wheeled cart. One is to be filled with the spraying mixture, the other with compressed air. When charged, the sprayer is taken to the vineyard and there, by opening a valve between the two tanks, the compressed air drives out the spraying mixture in a continuous stream until the last drop is expelled. This machine is designed for extensive operations. The whole outfit consists of a steam engine, an air-compressor, an air-storage tank, two carts complete (one is to be filled at the charging station while the other is being used in the vineyard), with necessary hose and nozzles. The expense of such an outfit makes it unsuitable for limited areas of fruit.

The kerosene sprayer is an essential piece of apparatus to be used for spraying kerosene mixed mechanically with water. This sprayer is especially fitted with two tanks, a small one for kerosene within a large one for water. The pump draws from both tanks according to a proportion, regulated by an index attachment and forces both liquids through the nozzles in a thoroughly mixed condition. Such a sprayer is used to spray no other insecticide or fungicide.

*Spraying Mixtures.*—The formulæ and methods of making the various solutions for spraying grapes are here given. The specific use of each one will be found under the particular fungous disease or insect on subsequent pages. The fungicides are as follows:

**Bordeaux Mixture.**—Copper sulphate, 4 lbs.; fresh lime (unslaked), 4 lbs.; water, 25-50 gals.

Dissolve copper sulphate in warm water in a wooden vessel and slake the lime in another vessel. After cooling, dilute each to 20 gals., and when the lime has settled dip it into the sulphate of copper, making the mixture. A simple test of the safety of the mixture is made by dipping a knife-blade or bright spade into it. If copper is deposited on the bright steel, more lime should be added until the test shows no more deposition of copper.

It is always best to make this mixture fresh for each spraying. Bordeaux mixture is the best fungicide known, and is the specific remedy for most fungous diseases of plants. Paris green, London purple or arsenate of lead may be used in connection with Bordeaux when insects are to be treated at the same time as the fungous pests.

**Soda Bordeaux.**—Soda, 1 lb.; copper sulphate, 3 lbs.; stone lime, 5 ozs.; water, 30 gals.

Observe precautions given for making Bordeaux. This mixture is easily made, and is less likely to injure tender foliage than the regular Bordeaux. It is a comparatively clear liquid.

**Ammoniacal Copper Carbonate.**—Copper carbonate, 1 oz.; ammonia, enough to dissolve the copper; water, 9 gals.

The copper carbonate is best dissolved in large bottles, where it will keep indefinitely, and it should be diluted with water as required. For the same purposes as Bordeaux mixture.

**Iron Sulphate and Sulphuric Acid Solution.**—Water (hot), 100 parts; iron sulphate, as much as the water will dissolve; sulphuric acid (commercial), 1 part.

The solution should be prepared just before using. Add the acid to the crystals and then pour on the water. Apply to dormant grape-vines with sponge or brush.

**Copper Sulphate Solution.**—Copper sulphate, 1 lb.; water, 15 gals.

Dissolve the copper sulphate in the water, when it is ready for use. *This shou'd never be applied to foliage, but must be used before the buds break.*

The insecticides are as follows:

Paris Green.—Paris green, 1 lb.; lime, 1 lb.; water, 200-300 gals.

Repeated applications will injure most foliage unless lime is added. *Paris green and Bordeaux mixture can be applied together with perfect safety.* Use at the rate of 4 ozs. of the arsenite to 50 gals. of the mixture. The action of neither is weakened, and the Paris green loses all caustic properties. For insects which chew.

London Purple.—This is used in the same proportion as Paris green, but as it is more caustic it should be applied with two or three times its weight of lime, or with Bordeaux mixture. The composition of London purple is exceedingly variable, and unless good reasons exist for supposing that it contains as much arsenic as Paris green, use the latter poison. For insects which chew.

Arsenate of Lead.—Acetate of lead, 11 ozs.; arsenate of soda, 4 ozs.; water, 150 gals.

Dissolve the acetate of lead in 4 qts. of hot water in a wooden vessel, and the arsenate of soda in 2 qts. of water in another wooden vessel, and when fully dissolved mix the two solutions in a tank containing 150 gals. of water. Used as a substitute for Paris green for insects that chew. A commercial article called "Disparene" has essentially this formula.

Kerosene Emulsion.—Hard soap,  $\frac{1}{2}$  lb.; boiling water, 1 gal.; kerosene, 2 gals.

Dissolve the soap in water, add the kerosene and churn with a pump for 5 to 10 minutes. Dilute 10 to 25 times before applying. Use strong emulsion for all scale insects. For insects which suck, as plant lice, mealy bugs, red spider, thrips, bark-lice or scale.

Kerosene and Water.—By the use of a kerosene sprayer, kerosene and water may be sprayed upon plants in a mechanical mixture in any proportion desired. One part kerosene to three parts water may be used on dormant trees, and one part kerosene to five parts water may be used in growing season. Recommended for scale insects and soft-bodied insects. A convenient substitute for kerosene emulsion. Use only on sunny or breezy days.

#### THE SPECIES OF GRAPE.

From all historical records, it is very probable that the grape is the oldest cultivated fruit, and in such instances, it was always the European or wine-grape that was concerned.

*Vitis vinifera*.—Owing to the long period of its cultivation, there are many varieties of this species. We know of it in Pennsylvania as the "hot-house grapes," being too tender for outdoor cultivation in this latitude. It is grown in grape houses for the tables of the wealthy. We know this grape also by the display of "California grapes" at fruit stands, and the entire product of raisins. The varieties of European-grapes, commonly planted under glass, are the following: Black Hamburg, the leading variety, of excellent flavor and good yielding propensities; Muscat of Alexandria stands at the head of the list of white varieties.

Failure in the attempts to grow the European grape in this latitude lead horticulturists to produce hybrids by crossing *Vitis vinifera* varieties with the varieties of American grape in cultivation fifty years ago. We have the results of such labors in the Roger's hybrids, such as Agawam, Lindley and Wilder.

When grape growers were convinced that little was possible with the foreign grape in Eastern United States, closer attention was paid to the improvement of our native grapes.

*Vitis Labrusca*.—The most important of the American species. It is commonly known as the Northern Fox-grape. It is found wild in the New England states and southward along the Allegheny Mountains to Georgia. It is a strong growing vine, climbing high on trees. The writer has collected specimens in York county, in this State, when in fruit, having eight to twelve berries to the bunch. The bunches seldom have over twenty berries in the native form. This is remarkable, in view of the fact that one of the earliest descendants of this species, the Concord, has bunches with fifty or more berries. This species has given us, besides the Concord, the Catawba, Niagara, Brighton, Moore's Early and many more good varieties.

*Vitis aestivalis*.—The Summer grape is native from Southern New York to Florida and westward to the Mississippi River. There are many botanical forms of this species showing its strong tendency to vary. Several good wine grapes have sprung from this species, such as Herbemont, Le Noir and Onderdonk. These varieties are better suited to Virginia and Missouri than to more northern states.

*Vitis vulpina*.—Riverbank grape. This is a tall, climbing plant, with bright green glabrous, thin foliage. It may be found from New Brunswick to West Virginia and westward to North Dakota and Kansas. It is recognized as the parent form of such varieties as the Clinton, Gelden Clinton, Elvira, Pearl and others.

*Vitis rotundifolia*.—The Southern Fox-grape may be found from Southern Delaware to Northern Florida and westward to Kansas and Texas. It is the parent species of the Southern Scuppernon

grape, a variety with large berries and having but two to eight berries to the bunch.

#### VARIETIES.

Only the best varieties that are suited to Pennsylvania are considered in this bulletin. Not all of them will prove satisfactory in the same soil. Varieties of grapes, like varieties of strawberries, must be selected with reference to soils and climatic conditions. Some varieties, like the Concord and Niagara, with strong vitality, are suited to a greater variety of conditions than most other varieties. It is impossible to make a selection of grapes that is best to plant in Pennsylvania, because of the varied character of our soils and the purposes for which the grower is planting. Commercial vineyards are often planted of one variety, like the Concord or the Niagara, or again, the Catawba. The yield in such cases is higher than where mixed varieties are planted, because many of the varieties with particularly fine quality of fruit are only moderate bearers and greatly reduce the yield per acre for the vineyard.

*Barry* (Rogers' No. 43).—A black grape that ripens with Concord. The branches are large, compact; berries, sweet and agreeable. A hybrid between the European and American grapes. Excellent for the home vineyard. Subject to mildews.

*Brighton*.—This is a cross between Concord and a hybrid known as Diana-Hamburg, so that it is one-fourth foreign. The bunch is large, berries medium, dark red or maroon. Very sweet and tender; ripens from the first to the middle of September. Only moderately productive. It is desirable for home use and may be planted for a local market.

*Campbell*.—An excellent early grape of the Concord type. It ripens about the first of September. The vines are strong, vigorous and productive. The bunches are large, compact and shouldered. The berries are large, tough-skinned and hang long on the stems after they have ripened. The flesh is tender and sweet. It is recommended for either the market or home use. It is a recent variety, originating in Ohio.

*Catawba*.—This old variety originated in South Carolina, where it was picked up as a native seedling in the woods as early as 1802. It is very late in ripening, so late in fact that it cannot be recommended for latitudes north of Pennsylvania, and even in this State it should not be planted at high elevations. It is grown successfully about the lakes of Western New York and along the southern shore of Lake Erie, on account of the beneficial influence of these lakes upon the climate. Catawba Island, in Lake Erie, was once a vast vineyard of this variety of grape, but the vineyards have given place to peach orchards. The Catawba berry is large, deep coppery

red, becoming purple when fully ripe. It is juicy, sweet, aromatic and rich. The bunch is medium in size, slightly shouldered. This variety is the best keeper. It can be packed in baskets and kept in cold storage, where an even, low temperature, just above freezing, is maintained until the last of March. It should not be planted extensively in new localities until a trial has been made with a few plants.

*Clinton*.—Bunches medium or small, compact. The berries are small, black, thin-skinned, not very sweet. It ripens late; is sometimes caught by frosts. The vine is rampant and hardy. This variety originated as a chance seedling at Clinton, N. Y., where the original vine is still growing at the age of eighty years. For home use.

*Concord*.—Undoubtedly the standard variety of American grape for many years to come. It leads the list for commercial and home planting alike. It is a thrifty vine, a regular and heavy bearer, and the fruit has a most pleasant taste. This variety originated about fifty years ago as a chance seedling in the garden of Mr. E. W. Bull, Concord, Mass. The seed is supposed to have been from the native wild Fox-grape, *Vitis Labrusca*. The branches are large, compact and shouldered; the berries are large, blue-black and covered with a bloom. It ripens in Pennsylvania latter part of September. The vine is extremely hardy; therefore, it is a very safe variety to plant. The most extensive grower of Concords in the world has 600 acres of this variety at Portland, N. Y.

*Delaware*.—The most valuable red grape for the commercial vineyard or home use. The bunches are small, compact, often shouldered; berries are small, thin-skinned, light red, exceedingly sweet and aromatic. The vine is not vigorous beside Concords, but with a suitable soil canes eight to twelve feet are made. It suffers often from over-bearing, but this can be avoided by proper pruning. This is an old variety, believed to be a hybrid of the European and American species, having been found in the garden of a Frenchman living in New Jersey about 1850.

*Green Mountain*.—(Sometimes catalogued as Winchell.) This is a very excellent grape for the table or home market. It is one of the earliest grapes ripening in this State. In the vineyard of the Experiment Station at State College it ripens by the middle of August. The bunches are small, compact; berries, small, greenish-white, with a thin bloom; the pulp is tender, juicy. Very sweet and rich. The vine is vigorous, resists fungous diseases and bears heavily.

*Lindley*.—(Rogers' No. 9.) This, like Barry, is a pleasant grape for the home vineyard. It is another hybrid that does credit to its originator. It ripens a week earlier than Concord. The branch

is medium, berries medium, red or reddish, flesh tender; juicy, sweet, aromatic. The vine is vigorous and hardy.

*Moore*.—A seedling of Concord and, therefore, a safe variety to plant where the latter succeeds. It ripens two weeks before the parent variety, and is so much like it that where both are grown the season of Concords is practically extended. The bunch is medium and the berries are large; black, with a heavy bloom. The skin is tender, necessitating careful handling of the fruit.

*Niagara*.—This is a leading white grape of commercial vineyards, as well as of the home garden. It is a noble companion for the Concord. It sometimes excels the latter in yield. The vigor and hardiness of the vine fit it for a great variety of untried conditions. It is a cross between Concord and Cassady, originating in Lockport, N. Y., not many years ago. The bunches are large, slightly shouldered. The berries are large, pale green, becoming yellow. The fruit ripens a little later than Concord.

*Telegraph*.—A variety originating near Philadelphia. It is valuable in the home garden because of its earliness. It ripens the last of August. The bunch is above medium, berries large, black, juicy and of good quality. The vine is vigorous and hardy.

*Worden*.—Another commercial variety that is planted extensively. Its value is attested by the fact that it is a seedling of Concord. It ripens a few days later than its parent variety and is an improvement in both quality and productiveness. The bunches are large, and the berries large, black and of good quality. The vine is vigorous and hardy.

It is needless to extend this list, for every worthy character of the American grape is represented in the foregoing varieties. The red, white and black varieties are the best out of the list of some 800 described varieties of American grape. The Concord, Niagara and Delaware are the safest trio to plant. The season of each may be extended by planting the earlier varieties, like Moore for black, Green Mountain for white and Lindley for red.

*Self-sterile Varieties*.—Every grape grower should acquaint himself with the fact that many modern varieties of the grape are self-sterile. That is, the pollen of the blossom is incapable of fertilizing its own pistil and, therefore, when such a variety is planted to the exclusion of others, no fruiting of the vine can be expected. If two or more varieties are planted in the same block they will insure the perfect pollination of each other, unless all of them are self-sterile.

This problem is well understood by the fruit grower in the case of strawberries, but it is a comparatively new discovery with reference to the grape. In the case of the strawberry, the varieties

which must not be planted alone, are imperfect in the blossom having no pollen because of the abortion of stamens. In the self-sterile grapes there is ample pollen present, but it fails to be effectual upon the pistils of the same variety. Self-sterility in the grape was made a matter for extensive scientific study by S. A. Beach, of the Geneva, N. Y., Experiment Station,\* and the results of his labors are reported in bulletins and reports of that institution.

In the list of grapes recommended in this bulletin the varieties shown to be self-sterile are Barry, Brighton and Lindley. It may be observed that all three of these varieties are hybrids of the *vinifera* and *Labrusca* species, and this, from our knowledge of hybrids in general, accounts for their self-sterility.

#### HARVESTING.

The harvesting time of the grape is an anxious period for the vineyardist. The culmination of a year's labor is realized in the ripened fruit—tender, sweet and luscious, but if it is not carefully handled by the pickers the proprietor sustains a loss in profit and a more serious loss in reputation. The season of grape picking extends from September 1, to November 1, beginning with the early varieties like Green Mountain, Moore and Campbell, and ending with Catawba. In commercial districts, women are chiefly employed as pickers and are paid one cent for an 8-lb. basket. One hundred baskets per day is a good day's work, though some pickers, when the crop is heavy, will cut 150 baskets. The grapes are picked in the baskets in which they are sold, if for immediate shipment. Ten or twelve pickers are enough to harvest the crop of forty or fifty acres of Concord.

The fruit should be fully ripe before picking. Some fruits will keep better if picked a little green, but this is not true of the grape. It will not improve in quality after it is cut from the vine.

In the Chautauqua grape belt the fruit is picked into the baskets in which they are shipped, as it is the custom in that region to market the crop at once. In the Lake Keuka region the fruit is picked in trays delivered to the packing house and then by other hands is sorted and packed into baskets and stored. Throughout Pennsylvania generally the crops from vineyards are harvested and promptly disposed of in local markets as soon as the fruit is ripe.

Two sizes of Climax baskets are used by grape growers. Some use the 9-lb. basket, which holds about eight pounds of fruit; others use the "pony," or 5-lb. basket, which holds about four and one-half pounds of fruit. The choice of size is determined by the market to which the fruit is shipped. The Concord from the Chautauqua

\*Bul. 157 and 169 N. Y. Exp. Station, Geneva, N. Y.



region go westward in 8-lb. baskets, and the Keuka district fruit goes eastward in 5-lb. baskets.

Inferior grapes are picked in crates and shipped to wineries to be converted into grape juice or wine.

*Packing Houses.*—In all large vineyards some form of a packing-house is convenient for the proper handling of the crop. In its simplest form, met with in the vineyards of Maryland, it consists of the canvas "fly" of a tent stretched over upright poles in the vineyard to afford shelter to the packers, who carefully arrange the fruit on the surface of the baskets as they come from the pickers. Better than this is the permanent shed placed somewhere between the vineyard and the loading station. Cut grapes should not be left to stand long in the sun. If grapes are stored, a combined storage house and packing room is built. The grapes are picked and delivered from the vineyard in trays holding twenty-five or thirty pounds of fruit, and from these are sorted by other hands and packed into baskets for storage and subsequent sale.

The storage house is built on the plan of an ice house, with opportunity for letting in the cold air of night and closing up during the day. In this way the interior temperature can be dropped to 40 degrees F. If the basement floor is built as a cellar in the side of a hill it makes a very satisfactory storage room, in which grapes may be kept until December and the Catawbas even later.

#### YIELDS.

A strong vine of the Concord grape, having all the advantages of soil and location, may yield thirty pounds of fruit, but such a yield could not be expected from all the vines in a vineyard. An average of twenty pounds to the vine would be a full crop. With 600 vines to the acre, the yield would be 12,000 pounds, or six tons, of fruit. This was the actual yield of vineyards in Erie county in 1901, when 1,500 8-lb. baskets were picked in the best vineyards; 1,000 such baskets are considered a good average crop. In 1903, owing to injuries from winter-killing, frosts and fungous diseases, the yield was less than half a crop. The average yield of all the vineyards in a district is regularly much below four tons, but the intelligent fruit grower must not count his chances with the average. He is better equipped to overcome the difficulties and often to avoid losses which the average man is not prepared to meet.

The crop of Concord in 1903 sold at from 15 cents to 20 cents per 8-lb basket in Erie county. Vineyards yielding 500 baskets to the acre, or two tons of fruit, would return to the proprietor \$75 to \$100 per acre. Two cents per pound is considered a very satisfactory price for the producer, and when a full crop is harvested the

return is nearly double the figures given. The annual cost of caring for an acre of vineyard and marketing the crop depends upon many conditions, but is estimated at from \$20.00 to \$25.00. The cost of developing an acre of grapes, including the expense of plants, trellis and care until the first crop is cut will depend upon a still greater set of conditions. Various estimates have been made, ranging from \$75 to \$100. These estimates include items of labor which the vineyardist supplies without a direct outlay of money.

#### DISEASES OF THE GRAPE.

Twenty years ago the grape grower was very little concerned about diseases affecting the grape. This is no indication, however, that no disease existed. On the contrary, as early as 1865, A. S. Fuller wrote of the black rot and mildew: "The diseases to which the grape is subject in this country are not numerous or very destructive, except in some particular localities, and these are confined mainly to the fruit." "Probably the most destructive disease known to affect the native grape is the black rot. This is the great scourge in the Western states." It is no longer confined to the Western states, but is making serious inroads upon vineyards of Ohio, Pennsylvania and New York.

There are four fungous diseases that are now causing losses in vineyards. They are commonly known as Black Rot, Anthracnose, Downy Mildew and Powdery Mildew. Every grape grower should acquaint himself with the symptoms of these diseases, that upon their first appearance he may make preparation for their prompt treatment. When a vineyardist, with a hundred acres in grapes, sees a fourth or a half of his crop destroyed by an insidious foe, he is not worthy of his business unless he promptly seeks to overcome that foe and protects the health of his vines and his own financial interests. In 1886, the United States Department of Agriculture made a careful examination of the fungous diseases of the grape and published information concerning the nature of the diseases and the most practical remedies for them. Such work has since been conducted by the State Experiment Stations to such an extent that a great measure of success may be expected by intelligently following the directions for treating fungous diseases.

#### BLACK ROT.

*(Laestadia Bidwellii.)*

Black rot is a disease but little known in Pennsylvania vineyards and less known to our grape growers. It has not yet established itself throughout the State so as to arouse general alarm. It has





Fig. 15. Showing two bunches of Concord's at left ruined by Black Rot; one bunch at right, saved by spraying.

been found in the State for at least fifteen years. In 1894, Prof. L. H. Bailey\* wrote: "Black rot was very prevalent in the vineyards situated on the banks of most of the lakes of Central New York. Some untreated vineyards lost from 50 to 75 per cent. of the crop from this disease, and even some treated vineyards showed a large amount of worthless fruit." In 1902, many vineyards in Erie county, Pa., were visited by this disease to such an extent that losses of crop were reported ranging from one-fourth to one-half of the crop. At a conference of the grape growers of the district held on May 5, 1903, at the call of the Hon. N. B. Critchfield, Secretary of Agriculture of Pennsylvania, it was evident from the testimony given that very few grape growers knew the black rot disease well enough to say whether or not it had existed in the district at an earlier date than 1902. For several years previous a successful war was being waged against this foe in the vineyards of Ohio, and yet the destruction caused by it was so great that many vineyards were being uprooted to be replaced with other crops because of the discouragement of the proprietors.

*Symptoms of Black Rot.*—The first appearance of black rot is made in July, from the 10th to the 25th, according to the climatic conditions. On the developing berries will appear livid brown spots, about the size of a pin head. These spots will increase in size gradually, and eventually the entire berry will be involved and have become a black-brown rotted berry, though still plump and firm. Where the original attack occurred, there will now appear little black pimples and the surface of the berry begins to sink. The black pimples appear rapidly over more of the surface until the entire berry is spotted with them and the berry has become greatly shriveled. The rotted berry is dry and adheres to its stem, so that it may be removed only by breaking it off. Upon the leaves and young stems the fungus also makes its appearance at this time. On the upper surface of the fully developed leaves appear reddish-brown spots one-eighth to one-fourth of an inch in diameter, nearly circular. When these spots are a few days old little black pimples, like those referred to on the berry, will begin to appear. They are not so numerous on these spots as upon a similar area of the berry. These black pimples are known as the pycnidia of the fungus. They are the fruiting portions of the fungus plant. In them are developed the spores by means of which the fungus is propagated and is spread to other berries and leaves.

The injury to the foliage by this disease is slight, but to the fruit it is most serious. Sometimes only one or two berries are destroyed, but when weather favors the spread of the disease, a half,

\*Bul. No. 76 Cornell Exp. Station, Ithaca, N. Y.

three-quarters or even all of the bunch is absolutely ruined. In such circumstances there is very little of the crop that is worth harvesting.

The disease is carried over winter in the black shriveled berries which are usually left on the vines. It is wise to remove and burn all such berries to reduce the chances of attack for another year.

Fig. 15 shows the condition of bunches ruined by black rot at time of harvesting.

*Remedy.*—The best treatment for this disease is to spray the vines carefully with Bordeaux mixture, using the 4-4 formula. That is,

4 pounds sulphate of copper.

4 pounds quick-lime.

50 gallons water.

#### DIRECTIONS FOR SPRAYING GRAPES.

\*“In view of the fact that spores are very abundant where the disease has prevailed it is well if all prunings and weeds are removed from among the vines and burned. Before vegetation or sprouting of the buds takes place in early May the vines should be sprayed with a fungicide to catch the spores that are awaiting the opportunity to germinate and effect an entrance into new tissue.

*“It is important to remember that no fungicide can kill the Black Rot fungus when it has effected an entrance into the tissue of the plant or berry. The value of the remedy is wholly as a preventive.*

“Before the grapes come into blossom the vines should again be sprayed to protect the new growth and foliage against attack. The blossoming period extends over ten days or two weeks and no spraying should be done at this time. A film of fungicide on plants cannot be considered effectual for more than two weeks and if dashing rains intervene the period is correspondingly reduced.

“After the blossoming period is completed the vines should again be sprayed, being particular to moisten all the foliage above and below as perfectly as mechanical devices and reasonable care will permit.

*“It is important to remember that a spore of the Black Rot fungus is exceedingly minute and if any portion of the vine is not protected by a film of the fungicide, a spore alighting on that portion may enter the tissue as easily as if no spraying had been done.*

“Subsequent spraying should be made at intervals of two weeks until the last of July. If no rot appears by that date it is not probable that it will come, but if it is known to be present in the neighborhood, it will be wise to spray once more about the middle of August.”

To properly spray a vineyard for black rot will require about seventy-five gallons of Bordeaux mixture per acre at each application. The entire cost of spraying a vineyard is estimated not to exceed \$6.00 per acre. If such an expenditure can save a quarter to a half of a crop, then certainly it is a good business proposition to spray grapes to protect them against the attack of black rot.

The results of careful spraying for black rot in Erie county are reported in Bulletin No. 66, of the Experiment Station, State College, Pa.

While all varieties of the grape are subject to the attack of black rot, it does not affect all with equal severity. The most susceptible varieties are Concord, Catawba, Salem, Lindley and Barry. The light-colored varieties are least subject to attack. Warm, wet weather favors the disease.

#### ANTHRACNOSE.

(*Sphaceloma ampelinum.*)

This is a comparatively new disease in America. It has been known in European vineyards under various common names as Charbon, Schwarze Brenner and Anthracnose. The last name is derived from the Greek and means coal-disease. In this country it has also received the name of "bird's-eye rot," owing to a striking resemblance of a diseased spot on a berry to a bird's eye. This disease has been more destructive to grapes in Pennsylvania than the black rot up to this time. It attacks the fruit, the leaves and the shoots.

*Symptoms of Anthracnose.*—The greatest amount of damage occasioned by this disease is upon the berry. Small dark brown or black spots appear on the surface of the green berry, and soon the center of the spot sinks. The spot grows larger and the sunken center becomes ashen-gray; the margin of the spot becomes purple, and the appearance of these three colors, purple, brown and gray in concentric rings, suggest the name of "bird's-eye rot." The entire grape does not speedily become involved, as in the case of black rot, unless the berry is attacked simultaneously at several points; neither does the berry shrivel up in the later stages of this disease as it does in the case of black rot.

Upon the shoots and leaves the same symptoms appear except that the purple margin is not commonly present, and the spot is not so likely to be circular, but rather elliptical, elongating in the direction of the stem. The diseased spots become black and look as if burned. Such spots on the canes are very noticeable when pruning the vines and it is very evident that the health of the vine is seriously injured.

The tender-skinned grapes are more susceptible to this disease than the tougher-skinned varieties. Diamond, Salem, Elvira, Brighton and others suffer most.

*Remedy.*—Anthracnose is the most troublesome disease in the vineyard because it is not so easily controlled as the others. Bordeaux mixture, which is so effectual in the treatment of the other fungous diseases, fails to give good results when used against the anthracnose. The treatment used by European vineyardists is the best remedy known. It consists in washing the vines and posts with a solution made of

Sulphate of iron, 110 pounds.

Sulphuric acid, 1 quart.

Water (hot), 26 gallons.

The sulphuric acid is first poured upon the sulphate of iron crystals and then the water is added. This solution is applied by means of a swab made by tying a few rags to a stick. All portions of the vine are washed, the parts being blackened as the liquid touches them. This treatment is given in the spring, while the vines are dormant.

#### DOWNY MILDEW.

(*Peronospora viticola.*)

This fungus occurs on the wild and cultivated grapes in nearly all parts of the United States, and is a native of this country. It is more severe on some varieties than others, though none of them are entirely proof against its attack. The downy mildew is a serious enemy of the grape, because it destroys the vitality of the vine. In this respect it is in reality a greater enemy than black rot. It is also more prevalent in Pennsylvania than the black rot and, therefore, the vineyardist should concern himself about this disease, learn to know its symptoms and the proper treatment.

*Symptoms.*—Evidences of this disease, when present, may be found on the leaves, stems or berries of the vine. On the leaves will be found patches of a lighter green than the normal healthy leaf. These patches are of various shapes and sizes, from one-fourth of an inch to two inches in diameter. As the disease advances these patches turn yellow, and later the leaves become brown and dead long before their proper time. When these patches are turning yellow, if the *under side* is examined, a patch with a frosty covering will be found to correspond in size and shape with the yellow patch on the upper side. This is the best symptom of the disease. The frost-like material is the fruiting portion of the fungus. The mycelium, or vegetative portion, is growing wholly within the tissue of the leaf



and when it is sufficiently developed to produce spores it breaks through the lower surface of the leaf in such patches as have been described. Microscopic white threads project from the leaf and bear the summer spores of the fungus. It is this condition which gives the disease the name of Downy Mildew. These white patches are more easily found upon varieties of grapes which have smooth leaves, like the Clinton and Delaware, because the cottony under surface of the leaves of the Concord type makes the downy patch less conspicuous.

On the canes this disease causes brown spots, slightly depressed. They are not as deep as those caused by anthracnose and not so dark. The evidence is not so frequently found upon the stem as upon the leaves.

When the berries are attacked, usually while small, they are checked in their development and do not gain full size. They turn brown or, if the fungus is fruiting upon it, the surface appears gray, and for this reason this disease has been called "Brown Rot" and "Gray Rot."

This disease is likely to make its appearance in this State about the first of July. It requires for its rapid and complete development a wet and warm atmosphere. A dry spell of weather will greatly check its growth.

*Remedy.*—The treatment prescribed for the black rot will serve to control the downy mildew. Since the fungus of this mildew grows within the tissue of the leaf, it is apparent that it entered sometime previous to the appearance of white patches. Consequently, since fungicides are preventives and not destructives, the Bordeaux mixture should be applied as early as the first of June. Four sprayings, applied at intervals of two weeks, will serve to keep the vines in good health and permit the normal development of the crop of fruit.

#### POWDERY MILDEW.

(*Uncinula spiralis*.)

This fungus is like the preceding one, a native of America, and like it attacks the wild and cultivated grape. The European varieties are particularly subject to the attack of the Powdery Mildew. The Downy and Powdery Mildews are often found in the same vineyard, but there are points of difference by which they can readily be distinguished. The former thrives in wet weather, the latter in dry weather. The former fruits on the under side of the leaf, the latter upon the upper side. The mycelium of the Downy Mildew is wholly internal to the plant, while that of the Powdery Mildew is wholly external to the plant, spreading over the upper surface of the leaf.

The mildewy character is more easily observed in this latter case because it extends over larger areas on the leaf, stem or berries. While it is more commonly present, it is less destructive than the Downy Mildew.

*Symptoms.*—On the *upper side* of leaves the mycelium of this fungus forms a cob-webby patch of delicate white threads—often the larger part of the leaf is covered in this way. After the disease has grown for some time the appearance of the leaf is gray, and if the mycelium is rubbed off, the green of the leaf may be seen with brown spots where the tissue has begun to collapse under the blighting influence of the mildew. Foliage attacked by mildews soon become so weak that they cannot perform their natural functions and turn yellow and die; the plant bearing them weakens in consequence and the fruit fails to be developed. When these mildewy patches are well-developed, numerous small globules in various shades of yellow, brown and black are scattered over them. These are perithecia or fruiting bodies which contain the winter spores for the reproduction of the fungus. When in large number they give a powdery appearance to the surface and hence, the name of Powdery Mildew. Under the compound microscope these perithecia are seen to have hair-like appendages with spiral tips and for this reason the specific name of the fungus is *spiralis*.

Any of the green parts of the vine or the young berries may be attacked by this fungus. The berries remain small when mildewed and become brittle. They split open often, showing raw tissue. Such fruit of course never ripens, but the greatest injury is to the vine and crop of the succeeding year. A weakened vine cannot support a crop of fruit.

*Remedy.*—As the mycelium of this fungus is external to the plant, it is not necessary to apply the remedy until the first evidences of its presence are discovered. As already stated, dry weather favors the development of this disease. Spraying the vines with Bordeaux mixture, as for Black Rot or Downy Mildew, will serve also to keep down the Powdery Mildew. If later spraying than August 1 is necessary it is better to use ammoniacal solution of carbonate of copper. This will leave no deposit on the fruit as the Bordeaux mixture does to the detriment of the fruit for marketing.

#### RIPE ROT.

(*Gloeosporium fructigenum*.)

This fungus attacks several kinds of fruits at the time of ripening. It seriously impairs the flavor of the fruit by making it taste quite bitter, and for this reason this rot is sometimes called Bitter Rot.

*Symptoms.*—The berries are attacked just as they are ripening

and turn reddish-brown. The whole berry may be thus discolored. After a time the affected berry develops little black pimples or pustules much like those of the Black Rot, but not so numerous. In this case, however, the berry does not turn black, but retains its brown color as it dries up. The dried fruit is more likely to drop to the ground, and in this respect, the disease differs from the Black Rot.

*Remedy.*—The application made for the Black Rot will be effectual in protecting vines against the Ripe Rot, particularly, if the later applications are made. As a rule, Ripe Rot never seriously reduces a crop, and, therefore, cannot be regarded in the same class as the four previously described diseases.

#### WHITE ROT.

(*Coniothyrium diplodiella*.)

This is a fungous disease of minor importance, but it may break out seriously in certain localities. It has been located in Ohio and New Jersey and no doubt it exists in Pennsylvania. It has been described as being in vineyards of Italy, though it is known to be a native of America.

*Symptoms.*—This fungus attacks the peduncle of the fruit and develops there. As a result the berry shrivels up and becomes dry. Later, little black pustules or pimples like those of Black Rot may be seen on the surface of affected parts. These are not likely to occur until the grapes begin to ripen.

*Remedy.*—The use of Bordeaux mixture is recommended as the best treatment to be given vines affected with the White Rot. Vines which have been treated for Black Rot or the mildews are protected against the White Rot also.

#### OTHER FUNGI ATTACKING GRAPES.

There are several other fungi that attack the grape, but never with serious consequence. The vineyardist who keeps a close watch upon the health of his vines will undoubtedly meet with some of them, but unless the evidences he finds correspond closely to the symptoms of the diseases already described, he does not need to be alarmed for his crop.

#### INSECTS.

The United States Department of Agriculture has records of over 100 different kinds of insects as feeding upon the grape-vine and yet this plant is looked upon as comparatively free from insect enemies. It is true that the grape phylloxera has caused the loss of many mil-

lions of dollars in the vineyards of France, yet in this, its native country, it is scarcely looked upon as an obnoxious insect, and in Pennsylvania few, if any, grape growers know what the phylloxera is. The rose-chaffer is the most difficult insect enemy to combat upon the grape-vine, but it is seldom that it occurs in alarming numbers. There are not more than ten or a dozen insects that need to be considered as insect enemies of the grape, and some of these may never be met with in the vineyards of Pennsylvania.

#### THE ROSE-CHAFFER.

(*Macroductylus subpinosus*.)

The "rose-bug" or "rose-chaffer" is well known to most persons. It appears about the time when grapes are blooming and feeds upon the flowers and later, the young fruit as well as the foliage. It has not for many years been known as an enemy of the grape, having formerly attacked, more especially the rose, eating into the buds and consequently received the name of "rose-bug." It feeds also upon the flowers and foliage of other plants as the cherry, blackberry, sumach, in fact no green thing is passed by when the rose-chaffer appears in swarms of thousands as sometimes happens. Not long ago a grape grower was alarmed by the presence of this insect in a vineyard of 65 acres. The flowering of the vines showed the first promise of a good crop of fruit when the rose-chafers visited the vineyard. The damage they would do was manifested in one day's operations, and men were set to work picking the beetles into buckets containing kerosene. In this manner, 15 bushels of insects were picked and killed, yet it was impossible to see where any advantage was gained by the picking. The supply seemed to be unlimited. It is needless to say that the crop of grapes was ruined before the insects completed the period of their existence, which closes about the last of July, and the grape grower was so discouraged that he was tempted to remove his vines and return to agricultural crops.

This insect operates in a wide range of territory from Canada to Tennessee, and westward to Colorado, but seldom in such overwhelming numbers as already indicated, except in New Jersey and Delaware, where it is particularly destructive.

*Description.*—This insect is a beetle about one-third of an inch long, with light brown wing covers and long crooked legs. When eating, several of them gather on the same object. They bury their heads deep into a rose bud. They are not disturbed by spectators, but may be easily knocked from plants. It is common to see them in pairs in the act of copulating, for before they die, they must lay the eggs for the next season's brood. The eggs are laid in light land, especially sandy land, in the month of July. The larvae soon hatch

from these eggs and feed upon the roots of grasses and other plants. By October they are full-grown, but remain in this condition in the ground until spring, when they transform into pupae. This occurs about two or three weeks before the time of the emergence from the ground as beetles.

• Dr. John B. Smith, of New Jersey, who has studied this insect under the most trying circumstances, when vineyards were devastated in two or three days time, says:\* “Occasionally, for a series of years, the insects appear in ever-increasing abundance, until the swarms are so great that they ruin not only vineyards, but orchards and gardens, eating almost every kind of fruit and flower. \* \* \* Fortunately, a period of abnormal increase seems to be followed by a period of decrease, though the lengths of the periods have not been ascertained.”

*Remedies.*—Under ordinary circumstances when but few insects appear, the vineyardist will consider the loss of a few berries too insignificant to undertake any warfare, but some good may be accomplished by the use of *four ounces of Paris green* in fifty gallons of water sprayed upon the vines where the insects are feeding. This remedy is better if four pounds of lime are added. The insects killed by such measures would greatly reduce the number of insects of the succeeding brood. When the rose-chafers appear in swarms, insecticides are too slow in their action to save the threatened crop. The only effectual method of removing the insects then is to pick them by hand, using a funnel over a bucket containing some kerosene and knocking the beetles into it. Enough men must be employed to accomplish the work quickly and it must be repeated not only every day, but several times each day until the period of their presence is completed.

These beetles are not likely to become so numerous in regions where sandy soils are not found.

#### THE GRAPE-VINE FLEA-BEETLE.

(*Haltica chalybea*.)

Some injury has been sustained in the vineyards of Erie county, due to the Grape-vine Flea-beetle, also known as the “steel bug,” from the steel blue color of its wing covers. Recently, its presence in large numbers has been reported from Cumberland county. Both the beetles and their larvae feed upon the young tender foliage of the grape-vine.

*Description.*—This beetle is a shining blue-black creature (sometimes having a greenish color) about one-fifth of an inch long, having the habit of most flea-beetles of jumping when approached. These

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\*Economic Entomology, by John B. Smith.

beetles appear in the spring before the buds of the grape have grown out, and seem to prefer for their food the interior tissue of the buds. In this way they forestall the growth of the bud, and it may be of all buds of the vine. After the beetles have been feeding for three or four weeks they lay clusters of eggs of an orange color on the under side of the grape leaves. From these eggs are hatched dark brown larvae, viscid and slug-like, that feed much of their time in companies, leaving nothing but the larger veins of the foliage. In June these larvae leave the vines, going into the ground, where they pupate and emerge in July as the second brood of beetles. These beetles feed upon the vines during the summer, but they do less injury then because the foliage is more mature. As winter approaches these beetles go into winter-quarters by concealing themselves under boards or rubbish and appear again the following May.

*Remedy.*—If all injurious insects could be despatched as easily as this one, there would be no occasion for heavy losses from such a source. If the vines are sprayed with Paris green (one pound to fifty gallons of water with lime) when the beetles first appear and again (four ounces to fifty gallons of water) when the larvae are observed, the vines can be fully protected. The young larvae may be killed with a weaker solution of poison than is necessary to destroy the beetles.

#### THE GRAPE-VINE FIDIA OR ROOT-WORM.

(*Fidia viticida*.)

This insect has been known in Pennsylvania vineyards since 1900, when it was discovered doing serious injury in the Chautauqua grape belt. It has been known for more than forty years in the Mississippi Valley as an enemy of the grape, but only as the adult feeds upon the foliage. The destructive work of the larvae was discovered just recently in Ohio. Vines upon which the beetles are feeding turn yellow in midsummer, some of them die outright. An investigation of the root system reveals the fact that the "root-worm" or larvae of the Fidia are present, and are the cause of the sickly condition of the vines.

*Description.*—This beetle is slightly larger than the "steel bug," being one-fourth of an inch in length and is closely related to it. It is of a brown color, with a hairy appearance, due to numerous short white hairs. When disturbed these beetles fold up their legs and drop to the ground after the manner of the Plum Curculio. This beetle appears in July and August and feeds upon grape leaves, eating small holes, usually in chains. Varieties of grapes with foliage having the wooly under side have only the upper surface of the leaf eaten.

The eggs are deposited in large cracks in the bark of the old vine. Many long yellowish eggs are packed together. The larvae on hatching fall to the ground and immediately burrow in search of the roots of the grape. They reach maturity in August when they are nearly one-half of an inch long, white, with a yellowish head. At this time of the year they construct earthen cells in the ground and hibernate as larvae until the following June, when they pupate. The period of pupation is about two weeks. The adult then appears in July and begins feeding upon the foliage.

*Remedies.*—As the larvae of this insect do the more serious damage and work in the ground while the adults feed upon the foliage, it is clear that at least two remedies are called for. As a matter of fact, a satisfactory remedy for the larval stage has not yet been discovered. No insects operating in the ground can be easily reached. A good practice to prevent the young grubs reaching the roots is to keep loose soil raised about the base of the vines. To destroy the larvae in the roots it was recommended by Mr. Webster, in Ohio, to inject carbon bisulphide in the soil about the roots, using from four to six fluid ounces per vine. The best results follow such applications made in the spring before pupation takes place. This is an expensive treatment and may be avoided by a persistent fight with the adults upon the foliage. The vines should be thoroughly sprayed sometime between the 25th of June and the middle of July, to kill the beetles before they lay their eggs, using two or three pounds of arsenate of lead in 150 gallons of water.

Professor Slingerland, of Cornell Experiment Station, has shown\* “that the pest can be more cheaply fought then (in the pupa stage) by proper cultivation than at any other time, and as effectively as by any other method;” “that thorough, frequent and timely cultivation of the vineyard, especially close around the vines, during June and July, will prevent the grape root-worm from being a serious menace in any vineyard.” Weedy vineyards invite insects and those which have suffered most from the depredations of this insect have generally been such as were neglected in cultivation. Feeding the vines with the proper fertilizers to induce a strong healthy growth enables the plants to resist or quickly overcome the injury caused by insects. It is the weakling that suffers most in adversity.

#### THE GRAPE LEAF-HOPPER.

(*Typhlocyba comes.*)

The Grape Leaf-hopper or “Thrip” is a very common insect pest. There is scarcely a grape-vine in the United States that does not have more or less of these tiny insects upon it. Serious damage is

\*Bul 268, Cornell Exp. Station, Ithaca, N Y

occasioned by leaf-hoppers only when they appear in immense numbers. They are so small and feed by piercing leaves with a needle-like proboscis, sucking out the plant juices, but the plant does not suffer until thousands attack it at once. Such is the case when an outbreak occurs that seems to fill the air. The vines are greatly weakened, so that the fruit does not develop, and on account of injured foliage, the new wood does not mature properly, and the next season there is practically no fruit.

*Description.*—This insect is about one-eighth of an inch long. The principal color is a light yellow, but the back and wings are variously marked with red. The young, known as *nymphs*, are light yellow only. The darker colors are acquired as they reach maturity, but particularly at the close of the season. There are no larval or pupal stages in this insect's life history. The eggs are laid on the under-side of leaves, but are very difficult to discover, particularly in varieties of grape like the Concord. Eggs are laid in June and July. They hatch in less than two weeks into nymphs or young "hoppers," and as such, resemble the adult insect, with the exception of being wingless. As they get older, wing-pads develop, and after moulting, they have the use of full-grown wings. These insects moult several times in the course of their development, and many white cast-off skins will be seen on the leaves among the living "hoppers." The adults hibernate in grass land and appear in the vineyard with warm weather in May.

*Remedies.*—A moderate number of these insects will require no treatment, for the injury will be slight, but when they arrive in swarms it is difficult to find an easy remedy. The best insecticide for sucking insects is kerosene, but to be effectual it must touch the insect. This material is recommended to be used either as an emulsion or a mechanical mixture. Twenty per cent. of oil will kill the insects, but will also kill the foliage of the vine, hence Prof. Slingerland used a 5 per cent. mixture to wet the "hoppers," and drive them to the ground, then turned a spray of 25 per cent. oil on them with very great success when treating the adults. When the nymphs are abundant a spray of kerosene emulsion or whale oil soap will kill all that are touched by it, therefore, it is essential that the spray nozzles are so directed that the under side of all the leaves receives the spray.

#### THE GRAPE-VINE PHYLLOXERA.

(*Phylloxera vastatrix*.)

This insect has caused greater losses in vineyards than all other insects combined, and from that point of view it should have been placed first up this list of insect enemies, but this bulletin is consid-



ering grape culture from the standpoint of the Pennsylvanian. While the Phylloxera is found upon grapes in this State, it is of minor consequence, for although it is an American insect, it causes very little damage to the American varieties of grape. When it was carried to Europe and spread in the vineyards of the wine grape, then only did it acquire the reputation which it now has. The annual losses in France have been estimated to be millions of dollars, and the search for *resistant* vines on which to graft the European grape is now going on.

The insect appears in two forms, one upon the foliage developing numerous galls upon the underside of the leaf. The Clinton and other smooth-leaved varieties are preferred. The other form exists upon the roots causing enlargements upon the rootlets about which they are feeding. It is this form which is doing the serious damage and is very difficult to control.

*Description.*—The Phylloxera is a yellow louse not over one-sixteenth of an inch long with a piercing proboscis. It is a wingless insect in all stages except the migrating stage. The life cycle is interesting because of the different forms of the insect. The root form hibernates in the ground and in the spring lays a hundred or more eggs upon the rootlets. The young, hatching from these eggs are, like their mothers, wingless and sexless, and soon they themselves begin to lay eggs. Several generations thus appear in a season. In August a few insects appear with wings, the migrating form, and emerge from the ground to fly to new fields. Here a few eggs are laid in the cracks of the bark on old canes, and the generation developing from them lays what are called the winter eggs. In the following spring these winter eggs hatch and the lice go to the young foliage and feed upon the upper side. The irritation occasioned by this act causes a green gall to form on the under side of the leaf just where a louse is feeding. The gall is hollow and open from the upper side of the leaf. In this gall are laid many eggs. From this time throughout the summer several generations of the wingless leaf forms succeed each other, each subsequent brood attacking younger leaves. At the approach of winter the young pass down the vines to the roots where they remain dormant until spring. It is at this point that we began the life cycle. It will be seen that two years are necessary to complete it.

*Remedy.*—As already intimated, this insect never injures our grapes enough to demand remedial measures. But since it is present it is well to know what it is and how it is treated. We should begin, by saying, it is very difficult to treat. It is better to avoid it. Carbon bisulphide is used with good effect by injecting the liquid into the soil about the roots. Not all soils are favorable to this treat-

ment. If vineyards are so located that they may be flooded with water, the phylloxera may be effectually killed by submersion. The remedy, however, which is applicable to all conditions is the practice of grafting upon resistant stocks.

#### THE GRAPE CANE-BORER.

(*Amphicerus bicaudatus.*)

During the summer months the vineyardist will discover young shoots which have apparently broken off at the old wood as if by accident and are turning black and dying. An examination will reveal the fact, if it was not an accident, that a hole in the cane at the base of the broken shoot fixes the responsibility upon an insect, the Cane-borer. It causes similar depredations upon our fruit and shade trees and shrubs.

*Description.*—The adult is a cylindrical brown beetle less than one-half of an inch long. It may be found in the burrow at the time the dying shoot is discovered, but soon leaves it to find dead roots or grape brush in which to lay eggs as it breeds in such rubbish.

*Remedy.*—As the insects never appear in large numbers and knowing its breeding habits, the only work called for is to keep the dead wood out of reach by promptly burning the prunings.

#### THE GRAPE-BERRY MOTH.

(*Eudemis botrana.*)

When grapes have become full size and begin to color, several berries of a bunch may be found to be discolored, as if unhealthy. The skin is clouded with purple or black and the pulp is penetrated by a "worm" or larva. This larva having fed for sometime in a berry eats its way out and into an adjacent berry, tying the two together by silken threads. When the inhabited berries are disturbed the occupant is very active in trying to escape.

*Description.*—The adult of this larva is a moth about the size of the codling moth. The wings are slate-colored with reddish-brown and white markings. It lays the eggs upon the berry and the young larva promptly eats its way into the fruit. When it has become full-grown it leaves the berry and passes to a leaf where it covers itself by cutting a flap of the leaf-blade which it folds over its body and fastens with silk threads. Here it transforms into a chrysalis and remains until the next season.

*Remedy.*—Poisons designed to kill the larvae before they enter the berries are impracticable, and there is no other vulnerable point in the life history of this insect. Fortunately, the loss is slight. Bagging the bunches before the berries are over half-grown is the most effectual means of protecting the fruit.

There are other insects which may be found feeding upon grapes, but none of them have ever caused enough damage to deserve consideration here. That pernicious insect, the San José Scale, has been found upon the grape, but it was caused by the proximity of a favorite host plant with which the grape locked branches. None of the insects here considered have been persistent enemies of the grape in Pennsylvania. The Rose-chaffer has broken out in a few localities in alarming numbers, but peaceful conditions soon returned and grape culture became again the pleasant task that it usually is. Fungous diseases are a much greater menace to grape culture than insects are, but both classes of enemies can be met with remedies, which if thoroughly and intelligently applied, will secure to the grape grower the pleasure and profit he anticipated in his vineyard.



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