MISSOURI

Agricultural College Experiment Station.

BULLETIN NO. 23.

GRAPE CULTURE.

COLUMBIA, MISSOURI,

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INTRODUCTORY.

In carrying out the objects of the organization of an "Agricultural Experiment Station," we cordially invite the co-operation of all persons interested in its success. Suggestions as to lines of experimental work, problems to be solved, inquiries relating to agriculture, horticulture, stock, and the dairy will be cheerfully received and answered as far as possible; but no work will be undertaken unless of public value, and the results of which we are at liberty to use for the public good.

Specimens of grains and grasses; seeds of fruit and forest trees; vegetables, plants and flowers that are true to name; varieties of beneficial and injurious insects; samples of mineral waters and ores, and whatever may illustrate any department of agriculture will be gladly received and due acknowledgments made in annual reports. Directions for collecting, packing and shipping such specimens will be furnished on application.

Bulletins will be issued at least quarterly, giving the results of experimental work as fast as completed, together with such suggestions and information as may be thought valuable to the farmers of Missouri.

The bulletins and reports of this Station are sent free to every citizen of Missouri who applies for them. Copies are sent as soon as issued to every newspaper in the State, to every Grange, Farmers' Alliance or other agricultural organization whose address can be obtained. Bulletins and reports are also sent to the leading agricultural papers of the country, and will be sent to *any* paper that may desire to exchange.

Letters relating to any special line of work should be directed to the officer in charge of that division, but all general correspondence relating to the work of the Station should be addressed to

EDWARD D. PORTER,
Director of Experiment Station.

COLUMBIA, Boone County, Mo.

GRAPE CULTURE.

CHARLES A. KEFFER,

Horticulturist.

Frequent inquiries on the selection and management of vines, and the invariable interest which has attended a discussion of the grape at Farmers' Institutes, has led to the preparation of this Bulletin. It is not a record of experiments at the station, though the practice recommended has been proven good in the station vineyard. Experiments in pruning and spraying are referred to, but the purpose of this article is to bring together in a brief intelligible way, facts that will be of practical utility in the care of grape vines.

VARIETIES.

The varieties of grapes that are used in open air culture in America have their origin in native species. Some are the result of crossing a European grape (*Vitis vinifera)* on an American. In the case of Roger's Hybrids the mother plant was a variety of *Vitis labrusca.* Others and by far the greater number, are either the offspring of some selected seedling of American species, or crosses of such seedlings. The ability to resist heat and cold of the several cultivated forms depends very largely upon their origin; varieties of the *labrusca* type are much more hardy and vigorous, as a rule, than those of *riparia* origin.

Having these thoughts in mind, it is not enough in selecting varieties for planting, that they have the desired color, size and flavor; for general planting, hardiness and vigor are prime essentials. Fortunately there are enough sorts having these latter qualities to allow a considerable range of choice.

If vines are planted for supplying the home only, as great variety in season, color, size and quality should be secured as possible. If a commercial vineyard is planted the first consideration must be profit.

Among the varieties that have been fruited at the Station, the following can be recommended for home use, the kinds of each color being named in the order of ripening.

BLACK.—Moore's Early, Worden, Potter, Concord, Eaton, Black Defiance.

WHITE.—Jessica, Elvira, Hayes, Moore's Diamond, Empire State.

RED AND AMBER.—Delaware, Brighton, Wyoming Red, Ideal, Jefferson, Goethe.

If not more than six varieties are desired, Moore's Early, Concord, Diamond, Brighton, Delaware and Jefferson or Goethe would be a good list. In naming the above varieties, hardiness, vigor and freedom from disease were considered equally as important as season, color, quality and productiveness.

PLANTING.

SITE.—If but few vines are to be planted in the village or farm garden, one or two rows may be placed where they will not interfere with the cultivation of other things, but where they may have full sunshine, and be trained to trellises running north and south. Whatever the size of the vineyard, the requirements of the vines will best be met in a soil of good fertility, well underdrained, having a southern or eastern slope. Drainage is the most important of these conditions. That the grape loves a moist soil is evident enough to anyone who has observed the magnificent growths of the vines which festoon the trees along our streams, but it should be remembered that the roots of these vines are not in stag-

nant water; a hard-pan sub-soil, which holds water and prevents natural drainage, can only be made fit for grapes by thorough tiling.

The advantage of a southern slope for vines is that such a slope receives the sun's rays more directly than level ground when the fruit is ripening. The soil, thoroughly warmed during the day, slowly radiates heat at night, and thus maintains the even temperature so important for the ripening fruit. During September the nights become cool, so that the point in question is an important one.

Locations with a good exposure and perfect drainage can easily be raised to the required fertility by the application of unleached wood ashes and barn yard manure, so that fertility may be considered the least important point in selecting a site for a vineyard.

DISTANCE.—The vines should be planted not nearer than eight feet apart, and ten feet may well be allowed such growers as Concord and Diamond. The rows should run north and south, so that both sides of the vine may receive full sunshine during the day. Eight feet is the least distance between rows permissible, and ten feet is better. It should be remembered that the grape is a vigorous grower, and in order to perfect heavy annual crops of fruit it must have ample root room. A good distance between rows will permit the use of harrow cultivation, which is a great saving of time and expense in large vineyards. Even in small gardens the vines will repay ample space.

PLATTING.—In setting a vineyard, or any permanent fruit plantation, it is an excellent plan to stake the entire plat before planting begins, to insure perfectly straight rows. If the vines, or trees, be then set with a planting board the result is a symmetry as exact as the staking. After determining the distance—say eight feet apart, in

rows ten feet apart, let the rows be carefully alligned, measuring the spaces between carefully. Then with an eight foot pole as a guide, place a stick about the thickness of a vine four feet from the end of each row, and measuring the intervals carefully, place a stick every eight feet. If well done, one may stand at one side of the plat and the sticks will form perfect radiating lines in every direction.

The planting board is made of inch stuff, four or six feet long and six inches wide, with a notch cut in the center of one side, and small auger holes two inches from either end and the board painted on one side. When the vineyard is staked, the planting board is placed in the row with the vine stick in the notch. Small pegs are then thrust through the auger holes and the other sticks are similarly marked.

PLANTING.—After the plat is pegged, the holes are dug, throwing the surface soil on one side of the row and the lower soil on the other. When ready to plant the board is replaced on the pegs, with the painted side up, as before, and the vine being set in the notch, it occupies exactly the position of the stick, and perfect allignment is thus secured. This method may seem unnecessary, but nothing so much mars the appearance of a vineyard or orchard as crooked rows.

The grape, as usually grown from cuttings, disposes its roots in a whorl about the base of the stem. Sometimes when the cutting is extra long, a second whorl of roots appears; in such cases the vine is often cut off just below the upper whorl, as shown at *a* in Fig. 1. In planting care should be taken to permit the roots the full spread they naturally assume. A small cone in the center of the hole, on which to place the plant, will be of use in this particular. The surface soil, well fined, should be placed next the roots, and the ground should be

thoroughly firmed about them, leaving a little loose soil on the surface. Whether set in the spring or fall, the vine should be cut back to three buds at the time of planting. When growth begins only the strongest shoot should be retained, the others being rubbed off when an inch or two long.

TIME TO PLANT.—As to time of planting, much will depend on the condition of the soil. If there is a good degree of moisture in the fall, there would seem to be no objection to autumn planting, particularly in the southern half of the state. The work is thus not in the way, when the rush of spring seeding comes. But if the ground is dry in the fall, as it was last year, planting should be deferred till spring. All plants are best set when the soil is moist, not wet, and this is as true of the grape as anything else.

AGE OF VINES.—A strong one year vine, such as is shown in figure 1, is better than any other for vineyard planting, and in all cases where fruit is not wanted at the earliest possible moment. Such vines do not lose so much root in digging as older ones, and they are in the best condition to start into vigorous growth. They will almost always have formed but one stem, and in cut-

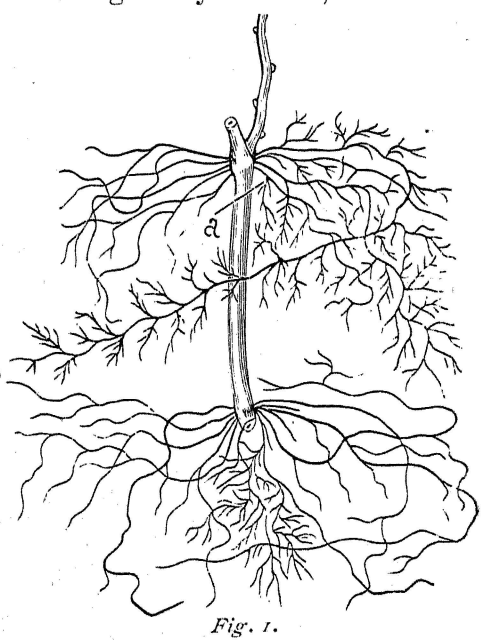

Fig. 1.

ting back, the buds left for growth are in direct line with the root-bearing stem, and so close to the ground that the new shoot, at the close of the season, will seem to have sprung direct from the root.

If a two year old vine is bought, a second whorl of roots, from the uppermost bud on the original cutting, will often have been made. If this upper whorl of roots is strong, and the cutting long, the lower part of the vine may be cut away, as at *a* in Fig. 1.

CULTIVATION.—From the time of setting, the grape should receive high culture. No other fruit requires such constant cultivation, and none so well repays it.

The first season, low growing corn or other crop may be grown between the rows without detriment to the vines. When the vineyard begins fruiting, however, clean and constant tillage is best. For this purpose the harrow tooth cultivators and the Acme pulverizer are the most useful implements. The latter is almost invaluable in land free from stones. It is a kind of harrow, six feet wide, and its special fitness for vineyard cultivation is in the fact that it stirs the surface soil only, leaving it in finest tilth, while not going deep enough to harm the surface roots of the vines. Its width permits much more rapid work than can be done with the ordinary cultivator. Another thing of value to the vineyardist is that it can only be used successfully in loose ground. When the weeds have attained a growth of four inches or more, the Acme is worthless. Hence frequent working is necessary if this implement is employed—a condition of the greatest possible benefit to the vines.

The hoe should be used in the rows quite as often as the cultivator passes between them.

When it is remembered that in bearing vineyards the root system of the vine is practically unpruned, and everything is done to encourage its growth, while in the annual

pruning of the top almost the entire growth of the season is cut away, and from the comparatively small surface left the crop of the next year is grown, the reason for thorough cultivation and perfect freedom from weeds will be apparent. During the summer the growing shoots are frequently pruned, in order to throw the energy of the plant into fruit development. It is necessary for the perfecting of the immense crops which the grape annually produces that all the moisture of the soil and the nutriment it contains should be saved to the vine. Weeds and grass are only so many passageways for moisture from the moist soil to the dry air above, and where they are not present in vineyards, and the moist soil is protected by a mulch of fine earth, the water passes from soil to air through the vine, which is thus supplied with an abundance of food. To realize the importance of cultivation for the vine, it is only necessary to compare the fruit in cultivated and uncultivated vineyards.

PRELIMINARY TRAINING.

FIRST YEAR.—The single shoot that is permitted to grow the first year may be trained to a temporary stake, or left to grow at will. No summer pruning should be done, as the whole purpose is to secure the strongest possible root growth, and this is in direct proportion to the leaf development. At the end of the first year the cane is cut back to three buds, one or two of which are permitted to grow the second season, and the third is rubbed off after the shoots have reached a length of an inch or two.

SECOND YEAR.—The second year the two shoots are trained up to a temporary stake, and every effort is made to get vigorous growth in the main canes. All lateral branches are pinched when they have made three leaves. This is a general rule for the pinching of lateral growths

during the summer, but it admits of modifications dependent on the variety grown and the method of training. Many writers on the grape recommend pinching laterals after the first leaf, but this is bad practice in many varieties, as it forces the bud at the base of the lateral to grow, and thus destroys the succeeding crop. In some varieties the laterals can be stopped after the second leaf, but in the station vineyard it was found that some of the most valuable sorts—notably Niagara, Diamond and Ideal—pushed the main buds when the laterals were stopped before their third leaf appeared. In all summer pruning, then, it has been the practice here, in vines which have received the most attention, to pinch laterals after the third leaf has formed.

PRUNING.

A distinction should be made between *training* and *pruning*. Pruning is the mere cutting away of useless or harmful parts, while training is the fashioning of the vine into any desired shape, in which it is to grow for several years. It is too often the case that vines are pruned merely, and not trained. In cutting away useless wood, the cut should be made, if on new growth, not more than a fourth of an inch beyond the last retained bud, or as close to it as can be conveniently done without injury to the bud. If the part cut away is old wood, it should be removed just beyond the last branch retained, in order that the wound may heal and no dead spur be left. These projecting spurs of dead wood are not only unsightly, but are prolific sources of disease, besides harboring fungus spores and insect eggs.

Pruning is best done with shears sold for the purpose. The best tried at the station are Lee's pruning shear; they can be had in two sizes, at $1.50 and $1.75 per pair.

The regular pruning of the grape is done at any time

after the fall of the leaves in autumn and before the buds begin to swell in the spring. The best time, because done most comfortably, is as soon as the leaves have fallen.

The summer pruning of the grape is practiced at intervals throughout the growing season, after the fruit is set. Its purpose is to increase the development of the fruit. Each fruiting cane grows laterals, the same as appear on a young vine. If these are not checked a great growth of wood is the result. This wood is practically useless to the plant, as the buds which are to produce the succeeding year's crop are borne on the same cane that holds the fruit. By pinching the tips of these laterals their growth is checked, and the material that would have gone into their development is retained in the bearing parts of the vine, where a good proportion of it is stored in the growing fruit. This is easily determined by comparing the fruit on two equally strong vines, one summer pruned, the other not.

A thorough summer pruning would require three or four operations; for a few weeks after the laterals are pinched their terminal buds push forth and growth must again be checked. In garden culture this work can be thoroughly done with ease, and few of the operations of the gardener are more interesting. In vineyard culture, many growers check the development of laterals by passing though the rows with a corn knife or sickle and shearing off the projecting growths. This operation is repeated two or three times, and while not as thorough as pinching, is very effective.

The prunings from the vines should always be burned, to destroy fungus spores, and insect eggs.

TRAINING.

There are many methods of training the grape, and these have been described in elaborate detail in books.

A few of the more simple systems are here given, not because others have no merit, but because these have been found easy, and have been attended with good results.

In general, two systems of training are practiced in this country: The spur system, in which the fruiting wood is cut back to short branches which are borne on long arms that are retained for several years; and the renewal system, in which an effort is made to reduce old wood to a minimum, and keep the vine constantly renewed. Of these the former is the more simple.

LONG ARM, SHORT SPUR.—This method had been practiced for several years in the station vineyard, and when I assumed charge of the department, the vines showed the result of the training. The usual practice in this method is to train two arms to the trellis, either in opposite directions, or one above the other. Every winter the past season's growth is cut back to two or three buds, thus forming the spurs. If care is taken from the first to have these spurs evenly distributed along the arms, and if in subsequent prunings but one fruiting spur is left at a place, the vines can be kept in fine condition for an indefinite period. But the danger is that the spurs are apt to multiply, and several fruiting branches are permitted to grow from the original spur, making it impossible to properly tie them to the trellis. The fruit of these crowded branches is always inferior in size and quality, owing to a lack of light necessary for perfect development. The vine, when trimmed at the end of the third year (whatever system of training is followed, no fruit should be grown the third year—or at most, one bunch to the vine) may have had ten two-bud spurs, five on each cane. From each bud a branch was produced. At the end of the fourth year, if the pruning should consist of merely cutting back the new growth, there would be *two* spurs at each place; at the end of the fifth year there would be

four, and this doubling would continue, to the great detriment of the vine. The properly pruned vine, at the end of the third year, would appear like the diagram. (Fig. 2.)

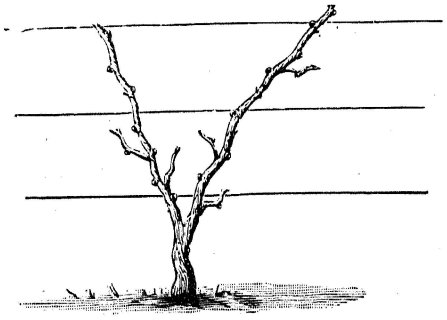

Fig. 2.

The fourth year not more than one bunch of grapes should be permitted to remain on each shoot. At the end of the fourth year the vine would appear as in Fig. 3. The outermost spur must be removed, and the remaining one cut back to two, or at most, three buds, at the dash (c) in Fig. 3. In this way there need never be crowding on the trellis.

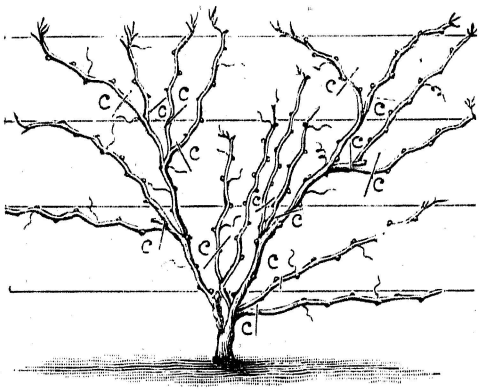

Fig. 3.

The spur method is the simplest way to train, and where one has had no previous experience, it is the best to begin on, as after a little practice other styles can be more easily learned.

A modification of the long arm short spur method is the following.

HORIZONTAL CORDON is a system of training especially applicable to small gardens. The second year a single cane is permitted to grow, and in the winter prun-

ing it is cut off at the lowest wire. The third year the two upper buds only are allowed to grow, the remaining shoots being rubbed off. The two shoots are trained to the bottom wire in opposite directions and are encouraged to make vigorous growth by pinching the laterals and removing any fruit that may form. At the end of the year the vine will resemble diagram (fig. 4) the lateral branches

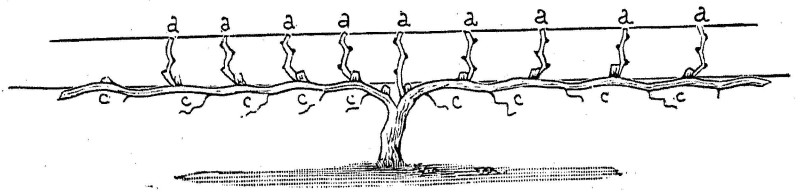

Fig. 4.

having been pinched several times through the season. The pruning consists in removing all the laterals (marked *a* in Fig. 4), and in cutting back the two main branches depending on the strength of the growth. If the nodes (distance between two buds) are short, enough buds must be rubbed off (marked *c* in Fig. 4), so that the remaining ones shall be not closer than ten inches apart. Often the nodes are six or eight inches long, and in such a case the alternate buds should be rubbed off, leaving the buds on the upper side of the branch.. Four or five buds may thus be left on each arm, so it will be seen that the length of the arms will depend entirely on the number of buds that are permitted to grow. Fig. 5. shows the vine pruned. The fourth year each bud will push forth, forming a fruiting branch, which

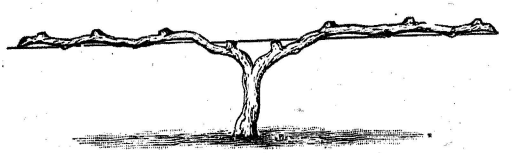

Fig. 5.

should be trained upright, tied to each wire and permitted to grow until the top of the trellis is reached.

The laterals should be pinched off as soon as the second leaf is formed, and kept pinched thereafter. Each shoot may be permitted to bear a bunch of grapes, all others being removed. When the leaves drop the vine will appear as in Fig. 6, and the bearing wood

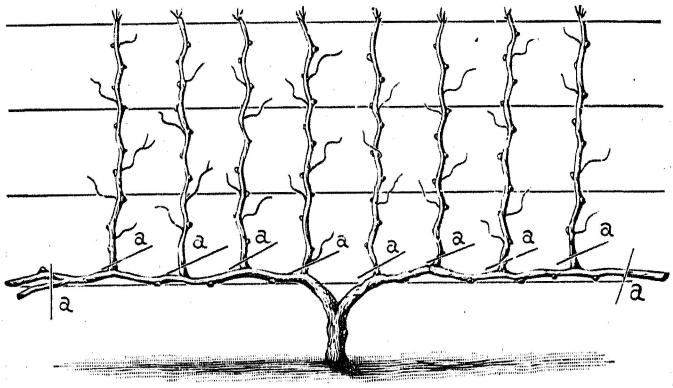

Fig. 6.

is all pruned back to one bud at the dash *a* in Fig. 6 while each arm is lengthened by one bud. The next year the bearing shoots spring from the single bud spurs, and are trained as before.

A modification of this system, producing rather better results, has two canes growing upright from each spur. The alternate canes are allowed to bear fruit and are pinched after the third or fourth leaf beyond the upper fruit cluster is formed. All flowers are removed from the intervening canes, which are grown to the top of the trellis. At the end of the season the fruiting canes (marked *a*) are removed entirely, and the others *(b)* are cut back to two buds, one for bearing a crop, the other to continue the spur, as indicated at the dash *c* in

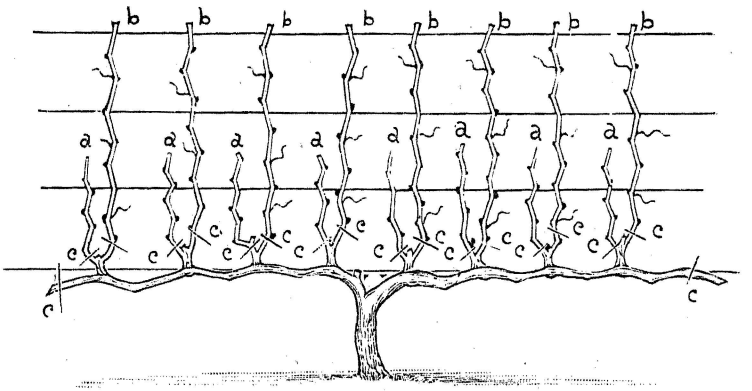

Fig. 7.

Fig. 7. In this system, the laterals on the fruiting branches are pinched at the first leaf, as the fruit is the only consideration.

The cordon can be lengthened from year to year, if care is taken to keep the vines in vigorous health and the spurs in good condition. The system requires too much care for vineyard culture, in which the renewal systems are to be preferred.

RENEWAL SYSTEMS.—There are several of these, all having for their object the more or less complete renewal of the vine every year. In the northwestern states, where it is necessary to cover the vines with soil in the fall, the low renewal is practiced, since by it the bearing canes shoot from the ground, and are easily bent to the earth and covered.

We can either adopt this method, the principal objection to which is the soiling of the fruit by rain spattering mud upon it, or we can use the high renewal. Both these systems have been practiced in the station vineyard with satisfactory results.

In the low renewal system two canes are grown the third year, as for the long arm short spur system. At

the end of the season they are pruned to three feet long, if a good growth has been made. The fourth year three or four buds at the base of the canes are encouraged to push forth and the shoots are trained fan-shaped on the trellis; the laterals being pinched to throw the whole growth of the vine into the main canes. At the end of the fourth year the vine will be as indicated in figure 8.

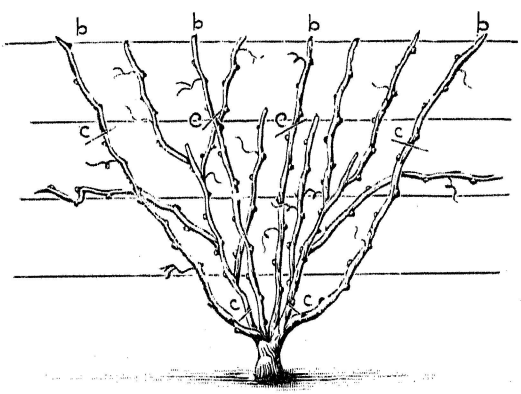

Fig. 8.

The two bearing canes having each produced one bunch of grapes (better none) and the four canes (marked b) having reached the top of the trellis. The pruning will consist of shortening in the canes *b* to three feet, removing all their laterals, and cutting out the old canes entirely as indicated at dash *c* in Fig. 8. The fifth year the canes *b* produce a crop of fruit, and from their bases four new shoots are trained, which become the fruiting canes the sixth year, the old ones having been cut away. It will be seen that practically the whole vine is thus renewed from year to year.

THE HIGH RENEWAL system differs principally from the last in having a main trunk which reaches to the lowest wire. Here it divides into two arms, as in the cordon training. At the close of the season the arms are cut back, the same as with cordon. None of the buds are rubbed off and in the third season the new growth is tied

to the upper wires. The two shoots nearest the trunk are encouraged to make the greatest growth possible. The pruning at the end of the third year consists in cutting off the arms just beyond the second cane on each, which is cut back to one bud, and in cutting back the base canes to six to ten buds, depending on their strength, as shown in Fig. 9, which shows the short spur from which the succeeding year's arms are to be produced, *b* representing the pruned canes for the next crop. The arms *b* are to be tied to the lowest wire, and the fruiting shoots from their buds are to be trained to the upper wires, the shoots from the short spurs being encouraged to make the greatest growth possible. At the end of the fourth year the arms *b* will be cut back to the first bud, and the shoots from the spurs will be reduced to six to ten buds, and in this way the complete renewal is accomplished. The fourth year the vine should not be permitted to overbear—two bunches to each shoot being a sufficient crop, and only one if ten buds are retained on each arm.

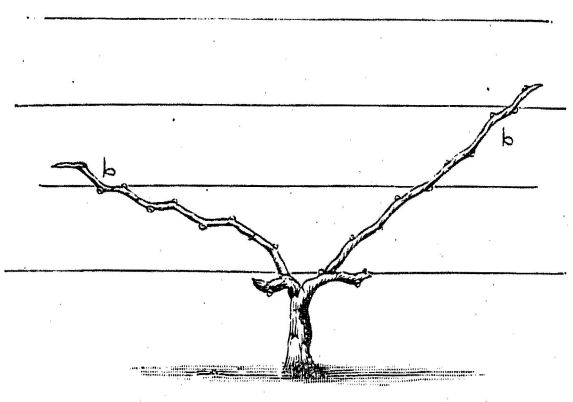

Fig. 9.

Experienced growers will find the Kniffen and Munson systems of training interesting. The Kniffen system, according to Professor Bailey, is supplanting all others in the New York vineyards. It consists in carrying the

trunk of the vine to the top wire, from five to six feet high. Here it divides and is treated exactly like the high renewal system. A similar treatment is given at the lower wire (but two wires are used). The vine when pruned thus consists of two long fruiting canes on the top wire, and two, a little shorter, on the second wire. The fruiting branches are not tied, but are permitted to hang loose, and only pinched when in the way of cultivation. The weight of the fruit bends the branches downward, growth is thus checked, and the fruit is more perfectly developed.

The Munson system, also figured and described in Professor Bailey's book on grape training, requires a special trellis. This is made by setting two posts instead of one at a place, and spreading their tops apart. Wires are run along the tops of the posts, which are connected by cross wires a little below their ends, and on the middle of this cross wire a third wire is stretched, forming a shallow V shaped arrangement. The trunk of the vine is carried to the middle wire, where it forms two long fruiting arms, and the fruiting branches grow up laterally over the higher wires, thus permitting an abundance of light and room, and securing perfect shelter to the fruit by the mass of foliage above. The pruning is on the high renewal order.

TREATMENT OF NEGLECTED VINES.

In hundreds of village and farm gardens of Missouri there are grape vines which have never been pruned, and whose growth has become so weak that it is no wonder their owners think the grape is not a success. Such a small vineyard, visited a few weeks ago, presented a serious problem. It was a *splendid* example of wrong treatment. It had not been cultivated for several years, and the vines had more dead canes than live ones.

The place had just changed owners and an effort was being made to improve it. Two methods of treatment were possible. The vines might have been sawed off at the ground, thus renewing the entire top—and this would have been most advisable—or they would have to be very heavily pruned. As a few grapes were wanted this year, the latter method was adopted. Each vine was carefully examined, to find, if possible, a healthy cane that sprung near its base. If two such canes on separate old branches, were found, so much the better. All the rest of the vine was cut away, and the fruiting wood thus chosen was cut back to three buds. Thus a vine which, under yearly training, should be capable of bearing forty buds, was only permitted to bear six. The canes were then tied to the lowest wire, arching the trunk for this purpose. It was hoped that by this means the vine might throw out new shoots from the base.

After several years of pruning under the spur system the trunk of the vine becomes very stiff and difficult to fasten to the trellis; frequently, also, the growth becomes enfeebled without apparent cause. Under such conditions it is advisable to renew the vine from the ground. If the trunk has been trained upright the vine can be induced to throw shoots from the ground by bending the old wood and fastening it to the lowest wire, after the usual pruning.

Two years ago it was thought best to renew the station vineyard, which had been trained for several years on the spur system as usually practiced in the west.

One fourth of the vines, mainly Goethe and Elvira, were cut off at the ground with a sharp saw. These, almost without exception, sprouted freely from the stump, and during the summer, from each root four strong canes were trained fan-shape, to the trellis. The renewal was a complete success and the crop of fruit set the past year—the

first since the operation—was in every way satisfactory. It should be noted, however, that one year's crop was lost by this method.

Another fourth of the vineyard was pruned a little closer than usual, and the old canes were tied to the lowest wire. During the summer all the canes that sprung from near the ground were carefully trained, but comparatively few of the vines gave shoots from the root. Many of them gave strong canes from the arch, so that they could be renewed at that point. It will be observed in pruning each year, that in some vines a lateral branch will seem to develop at the expense of all that part of the vine beyond it, and in such cases the weak portions should all be cut away, thus to a certain extent renewing the top. A very little experience in pruning will teach this important lesson, that whatever the system of training determined upon, each vine must be pruned according to its own growth, and hence no two vines can be treated exactly the same way.

In bringing up a neglected vineyard to fruitfulness, the cultivation is quite as important as the pruning and training, for it almost always happens that the unpruned vines are never cultivated.

To test the effect of different degrees of pruning, two rows of Concords were treated as follows the last year. The rows were divided into sections of eight vines each. The first section was pruned to spurs of one bud each, the second to spurs of two buds, the third to spurs of three buds, the fourth to spurs of four buds, the fifth to six long spurs (six or seven buds), and the last was left unpruned. As the vines had been trained on the short spur system for several years, that method was adopted. The proper summer pinching was given all the vines except the unpruned ones, which were not pruned. All the vines received the same spraying—four applications

of dilute Bordeaux mixture. Unfortunately when the fruit was ripe, some bunches were picked by visitors, so that a record of the crop could not be made. But the appearance of fruit of the different sections was striking. The best bunches, and the most marketable grapes, were produced by the two bud section, though not differing greatly from the one bud and three bud. The *most* bunches were produced by the unpruned section, but the berries were only from *one-half* to *two-thirds* as large as on the two bud, the bunches would not average *one-third* as large, while the amount of black rot was noticeably greater. The fruit on the two bud section sold for six cents a pound, while that on the unpruned vines sold for only three cents per pound, so that the pruned vines were much the more profitable.

An important point in the above experiment is that the pruned vines were freer from fruit rot, doubtless because the spray penetrated every part of the vines, while the very thick growth of the unpruned vines made this impossible.

SPRAYING.

The greatest enemy of the grape in Missouri is a fungus called *brown rot* or *black rot* which attacks the leaves, appearing as small yellowish spots, and afterward the berries, which soon turn brown, decay, and fall off or shrivel and dry up. If all the berries of a bunch are not affected the appearance of the bunch is ruined and hence the crop is made comparatively worthless. Next to this disease in importance is the powdery mildew, which first appears on the midribs of the leaves as a fine powdery net work—the same condition is soon seen on the fruits. Powdery mildew is not so common in this state as black rot, though where a vine is affected it is quite as destructive.

The station vineyard has been singularly free from all insect depredations, and no report of serious damage from insects has been received from any part of the state. Two years ago one vine in the station vineyard was badly infested with powdery mildew, but the diseased parts were cut away and burned and the subsequent growth was powdered with fostite. The disease has not since been observed.

The entire vineyard has been infested with black rot, and experiments in spraying, though not conclusive in their results, are certainly encouraging.

A most intelligible description of the disease known as Black Rot (*Loestidia Bidwellii*) can be found in Bulletin No. 6 of the Delaware station, issued in October, 1889. Summing up the botanical characters of the fungus, Professor Chester says:

"1. That the disease is caused by a microscopic plant or fungus, whose vegitating portion consists of a net work of fine threads, growing through and in the affected parts of the leaf and berry, causing in one case the spotting of the leaf, and in the other the decay and shrivelling of the berry.

"2. That the fungus bears a number of different kinds of fruit; which are shown as pustules (spots) on the surfaces of the diseased parts * * *.

"3. That associated with these last named fruits are different spore bodies * * *.

"4. That any of these spore bodies are capable of originating the disease in unaffected parts of the vine." There are four of these fruits and four kinds of spore bodies, so it will be seen that the means of spreading the disease are abundant. Moist, warm conditions favor the disease, while dry, cool conditions have the opposite effect.

The rot being caused by a fungus that grows within the vine, the whole treatment must be preventive, as any-

thing that could reach the fungus after it is developed, would kill the vine.

The spores of the fungus will not germinate in solutions of copper salts, and some form of salts of copper have been applied to the leaves as a preventive of the disease. The slight amount taken up by dew or other moisture is sufficient to prevent the growth of the spore.

During the past five years many of the stations have made careful experiments in the use of different forms of copper salts as a preventive of grape rot and of mildew. Varying degrees of success have resulted, but Bordeaux mixture has been found, almost without exception, the most effective remedy applied. In the earlier experiments a quite concentrated solution was used, but more recent experiments have proven weaker solutions to be equally effective. The following practice is now regarded as the best that can be pursued in the treatment of grape fungi.

RULES FOR SPRAYING.

1. As soon as possible after the leaves drop in the fall, prune the vines, and burn all refuse that can be raked from the vineyard: leaves, decayed berries and pruned wood. In this way many spores are destroyed.

2. Before buds swell in the spring—as late as can be—spray thoroughly the vines and trellis with a strong solution of blue vitriol—one pound to ten gallons of water.

3. After growth has started the vines should receive five applications of Bordeaux mixture, at intervals of two weeks. If rains are frequent one or two additional applications will be advisable.

The last spraying may be done with carbonate of copper and carbonate of ammonia mixture, which is colorless and will leave the fruit at ripening free from the discoloration of Bordeaux mixture.

BORDEAUX MIXTURE.—The original formula for making Bordeaux mixture is as follows: "Dissolve six pounds of copper sulphate (blue vitriol, blue stone) in hot water; in another vessel slack four pounds of quick lime and bring the same to the consistency of milk. When cool slowly add the milk of lime to the copper solution, straining the same through a sieve, stir continuously, and dilute to twenty-two gallons."

The *Dilute* Bordeaux mixture, now generally used and considered equally as effective as the above, is made in the same way, using two pounds of copper sulphate and two pounds of lime. Experiments at this station, with one pound each of copper sulphate and lime to 22 gallons water, have shown even this quantity to be effective.

THE CARBONATE OF COPPER AND CARBONATE OF AMMONIA MIXTURE.—Mix together three ounces of carbonate of copper and one pound of pulverized carbonate of ammonia. This will entirely and quickly dissolve in two quarts of hot water, after which it is diluted to fifty gallons with water.

Experiments at this station the past two years have proven that the grape crop is greatly increased by the use of Bordeaux mixture. The past season, Concord grapes that recieved the spray of copper sulphate solution before growth started, and four applications of the most dilute Bordeaux mixture (1 lb. each copper sulphate and lime to 22 gallons water) by the time the berries were half grown, produced a much better crop, with much less rot, than vines of the same variety which had never been sprayed. There is no question but that spraying the grape pays well.

SPRAYING APPARATUS.—Where only a few vines are grown, as in small gardens, a small hand force pump can be used to advantage. Various implements of this kind

are now offered, pump, hose and nozzle, all complete, for from three to six dollars.

The pumps are useful for washing windows, white washing, and other domestic purposes, aside from their value for spraying purposes.

In vineyards some form of knapsack sprayer, which will cost from nine to twelve dollars, will be found most useful if the rows are planted close. Where the rows are eight or ten feet apart a barrel sprayer will be more useful, as it can be carted through the vineyard and the work done more easily and rapidly.

An excellent barrel pump is sold by a Lockport, N. Y. firm, and the Nixon Company makes a satisfactory knapsack sprayer.

BAGGING TO PREVENT ROT.

Two years ago an extensive experiment was made in bagging different varieties of grapes as a preventive of rot. One pound manilla paper bags were used. In most varieties the bags were put on immediately after the blooming and in all such cases it was a complete success. In a few varieties that were not bagged until the berries were the size of buck shot a little rot appeared. When performed early this operation seems a perfect preventive of rot. Not only so, but the bagged fruit is much more beautiful, never having come in contact with dust or rain.

In applying the bag, first open it and square the end, carefully draw the bag over the bunch, and pin it above the cane to which the bunch is attached. It may sometimes be necessary to slit the bag on either side an inch or so at the top, to make it lap over the cane better. Where but few grapes are grown bagging is much more satisfactory than spraying, so far as protecting the fruit from rot is concerned, but the spray keeps the foliage in fine condition and thus increases the vigor of the vine.

SUMMARY.

1. With few exceptions, grapes of the *Labrusca* species, of which Concord may be taken as the type, are the most satisfactory for general planting.

2. A warm, rich well-drained soil is best for the grape.

3. Almost all vines should be planted at least eight feet apart.

4. Careful allignment greatly improves the appearance of the vineyard.

5. Strong one-year old vines are most desirable for planting.

6. Thorough shallow cultivation is essential. The Acme pulverizer is the best implement for the work. The cut-away harrow is also satisfactory. If vines have been planted less than eight feet apart, a harrow-tooth cultivator is the best implement to use.

7. The pruning of the first two years must be done with reference to the system under which the vine is to be trained after it begins fruiting.

During this time the vine should become thoroughly established.

8. The best time for the principal pruning is soon after the leaves drop, in autumn, but pruning can be done at any time during the winter, when the vines are not frozen.

Summer pruning consists in pinching lateral (stipulary) branches in order to encourage the development of the fruit and the bearing wood for the succeeding year.

9. The long arm, short spur system of training is usually the most satisfactory for the inexperienced grower, but the renewal systems are highly recommended.

10. The most satisfactory way to bring a neglected vine into vigorous growth is to cut the vine off at the ground, and train the shoots that will spring from the stub, on one of the renewal systems. Bending the trunk of an old vine to the lowest wire of the trellis will usually induce new shoots to spring from the arch or below, and the vine can be renewed in this way.

11. The principal diseases of the grape are powdery mildew and black rot, both of which can be controlled by spraying with Bordeaux mixture.

Five applications of the mixture, sprayed on during the early part of the season, will usually be sufficient.

12. Bagging the grapes as soon as the bloom has fallen will prevent rot, and the fruit is more beautiful when grown in bags. This method is advisable where but few vines are grown.