

August 1935

(Circular 134 Revised)

CIRCULAR 177

AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE

MANHATTAN, KANSAS

DEPARTMENT OF HORTICULTURE



PICKING GRAPES IN THE COLLEGE VINEYARD

GRAPE GROWING IN KANSAS¹

R. J. BARNETT

INTRODUCTION

The American grape is a comparatively new cultivated fruit. Old-world grapes were introduced at the beginning of the Colonial period and their culture attempted for two hundred years. It was only after repeated failures with these that the attention of vineyardists

1. Contribution No. 132 from the Department of Horticulture.

Acknowledgment.—The photographs used in illustrating this circular are the work of Prof. W. F. Pickett, of the Department of Horticulture.

was turned to the wild species of America. The pioneers faced first of all the problem of finding adapted varieties. This problem was solved mainly by chance when such varieties as Catawba, Delaware, and Concord were discovered. They have been supplemented rather than supplanted by later varieties produced by such plant breeders as A. S. Rogers, Jacob Moore, T. V. Munson, and the New York State Agricultural Experiment Station.

A second difficulty which outlived the lack of suitable varieties and for many years impeded progress, was the attempt to apply European methods of culture to the production of American grapes. It was not until experience had shown that these were inadequate and modified methods were devised that success was possible. Immigrants from the grape-growing countries of Europe still do harm by following and disseminating foreign practices which are ill-adapted to conditions and varieties in this country.

OUTLOOK FOR COMMERCIAL GRAPE GROWING IN KANSAS

Grape growing on a commercial scale is confined to a small number of localities in Kansas. At present no expansion is taking place in these districts and no new centers of production appear to be forming. Grapes could be grown in nearly every county of the state, but commercial development should be restricted to those sections in which climate, soil, and markets are especially favorable.

Leading counties in order of present grape acreage are Doniphan, Johnson, Wyandotte, and Shawnee, with the planting in Doniphan county exceeding the sum of that in the other three counties. Reno and Sedgwick counties lead in the central part of the state. With the return of larger purchasing power new plantings could be expected to yield a profit in these counties and in Atchison, Leavenworth, Crawford, and Douglas. The total grape crop for Kansas in 1932 was reported as 4,873,000 pounds, about the amount the cities of the first class in the state should consume.

Size of Vineyard.—When given good care the American grape is a heavy-bearing plant, 10 pounds to the vine being an ordinary crop. A family of four persons could well use 100 pounds during a season, so about 10 vines will suffice for a home vineyard. Kansas commercial vineyards vary in size from less than 1 acre to as many as 30 acres. If combined with the production of other fruits, and this is the safe method of farm organization, 3 to 10 acres should prove an economical size. Twenty or more acres become a major enterprise and require a great deal of careful management. Profits do not always increase at the same rate as do the acres in the vineyard.

VARIETIES

Many species of grapes are found growing wild in America, but only a few of these have yielded cultivated varieties of importance. Among these *Vitis labrusca* is far in the lead, as from it comes Concord and the other varieties of the Concord group. *Vitis aestivalis*, a species similar to *V. labrusca*, but found farther south, has con-

tributed a few varieties. *Vitis vinifera*, the European grape, through crossing with American species, especially *V. labrusca*, has had a strong influence on the varieties grown here, but no variety of pure European origin is adapted to Kansas climate. The wild grapes of the state have yielded no cultivated varieties of importance.

The department of Horticulture of the Kansas Agricultural Experiment Station has tested nearly 200 varieties of grapes. The first experimental planting was made in 1888, the old vineyard being finally abandoned in 1922. The results of the variety tests in this vineyard were reported in Bulletin 110, published in 1902.²

Figure 1 represents typical leaves of important American grape varieties. Many vineyardists can identify vines, when they are bearing no fruit, by their plant characteristics alone.

Concord.—Concord is the variety which serves as a standard by which other American grapes are judged. It belongs in the group of black grapes, ripens in midseason, and is of good quality. The plant of Concord is hardy, vigorous, productive, and resistant to pests. It is in general the best variety for planting in Kansas, especially in commercial vineyards. It is used for jelly, dessert, and juice.

Moore Early.—Another valuable variety of the *labrusca* type is Moore Early. In fruit it is similar to Concord, its parent, but ripens one to two weeks earlier. The vine is less vigorous and productive than that of Concord and is not adapted to so wide a range of either soil or climate. Fertile, well-drained soil, thorough cultivation, and unusually heavy pruning are necessary for securing good yields of Moore Early. The quality of fruit is not so good as Concord, but is better than many other early varieties.

Worden.—Worden would be the leading variety of grapes in Kansas were it not handicapped by a few bad characteristics. It is of the Concord type and excels that variety, its parent, in earliness, size of both bunch and berry, quality, and vigor of vine. However, it has a thin skin which cracks badly during wet weather, and more juicy flesh which cause its storage and shipping to be considerably more hazardous than with the Concord. Worden is one of the best varieties for the home vineyard.

Niagara.—The first three varieties described are all black grapes. Niagara is a white grape of a type similar to the preceding varieties and is one of the leaders in its color class. Though like Concord in many ways it excels in size of berry and bunch, but is inferior in hardiness of plant and suffers greater damage from spring frosts. It is also more subject to injury by fungous diseases during seasons favorable to these pests. Niagara is probably the best of the white grapes for general planting in Kansas.

Other Varieties.—Commercial growers will generally find it advantageous to hold closely to the varieties described above, especially so if their fruit is sold on the general market, but if other

2. Dickens, Albert, and Greene, G. O. Grapes. Kan. Agr. Expt. Sta. Bul. 110:223-250. Illus 1902. (This publication is no longer available for distribution.)

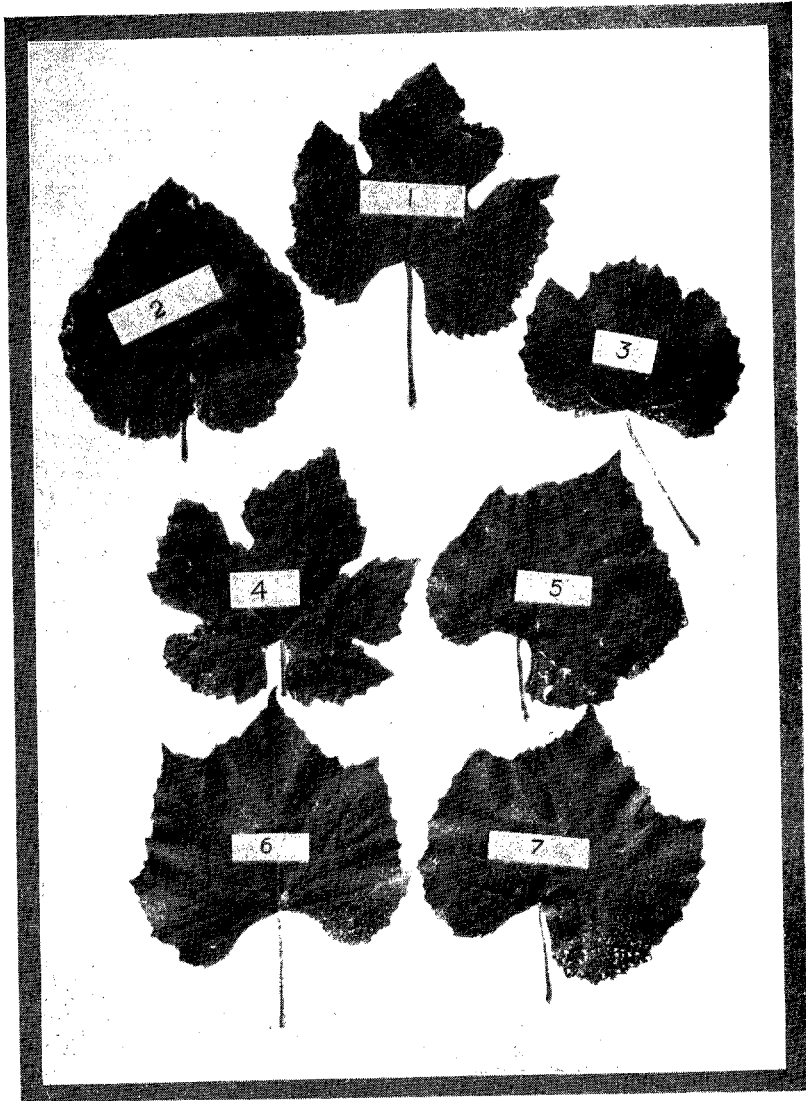


FIG. 1.—Typical leaves of important American grape varieties. They are: (1) Brighton; (2) Agawam; (3) Diamond; (4) Niagara; (5) Moore Early; (6) Concord; and (7) Worden.

varieties have proved their local worth and sell well on the local market they may be planted with safety. Even commercial growers enjoy testing new and promising varieties and growing some of the high-quality hybrid grapes for home use, but these should be planted only in small numbers. The following varieties are high in quality and well worth growing, in spite of their faults as to color, disease resistance, or lack of hardiness: Red varieties—Lucile, Brighton, Agawam, Catawba, and Delaware; white varieties—Winchell (Green Mountain), Pocklington, and Diamond; black varieties—Campbell Early and Fern Munson.

Variety tests conducted at the United States Department of Agriculture field station, Woodward, Okla., indicate that for the dry sections of southwestern Kansas a different selection of varieties may be advisable. Beacon, a Munson hybrid, is a black grape similar to Concord but gives three times the yield of Concord at Woodward. It ripens in midseason and should be tested on moist, sandy soils in the southwestern part of Kansas for home use and local markets. Catawba, an old variety of red color and high quality, is worthy of trial also.

VINEYARD SITES

The old idea that land too barren, steep, or rocky for any other use is a good place to set out grapes was long ago proved erroneous. The site for a vineyard must be chosen with care even though the grape is better able to adjust itself to unfavorable conditions of site than are most other fruit plants. The soil, air drainage, and exposure to sunlight and winds are the important elements to be considered. Isolation of the vineyard from wood-lot areas is desirable since there is then less danger of attack by certain native insects.

Soils.—Some species of American grapes are selective in their soil requirements, but the principal cultivated varieties thrive on a wide diversity of soil types. Grape soils must be well drained. Standing water either on the surface or in that part of the subsoil occupied by the grape roots is quickly injurious. This does not mean that the grape requires a dry soil; rather that the soil should be well drained but still have the capacity of absorbing and holding, through periods of drouth, a liberal supply of capillary water. This and other benefits are promoted by a high content of organic matter or humus. In general a loam or a sandy loam of good fertility will prove best for Kansas vineyards although good grapes are grown on soils of other types. High fertility, abundant moisture, and good drainage are necessary characteristics of a profitable vineyard soil. A vineyard planted on a soil lacking any of these qualities will prove short lived and unproductive.

Air Drainage.—The grape does not bloom earlier than other fruit plants, but the frost hazard is somewhat greater than with the apple. This results from the habit of growth of the grape shoots. These come from overwintering buds on canes which grew the previous summer. They start growth early in the spring and are for several weeks very succulent and tender. These shoots are fre-

quently destroyed by frosts before the blossoms, which are borne laterally on them, have opened.

Because of this hazard the vineyard site should have good air drainage, *i. e.*, should be on sloping land or on nearly level land which lies somewhat higher than surrounding areas. The present station vineyard at Kansas State College is located on sloping land, but a rather dense windbreak obstructs the air drainage across the lower or south end. This causes the vines in that part of the vineyard to be much more seriously injured by late spring frosts than are those situated at higher levels on the slope.

Exposure to Sunlight and Heat.—Kansas is favorably situated in regard to sunlight and heat, so grape varieties to fill the season can be grown in nearly all parts of the state regardless of the slope. However, each variety seems to thrive best and ripen its fruit most fully and uniformly when exposed to a rather definite optimum total of heat and of light. Hence, the wise selection of the slope with respect to varieties grown may well receive consideration. A south or a west slope favors early ripening and full maturity of the grape. North slopes delay ripening and may prevent the development of a normal sugar content in the fruit, but the soil is usually more fertile and more retentive of moisture. Dry air, as well as bright sunlight and rather high mean summer temperature, is favorable for grape growing.

To recapitulate: The vineyard site should be on a rather light but fertile, deep, and well-watered soil; it should have sufficient slope to provide good air drainage, and exposure to sunlight and wind. Direction of slope should be decided on the basis of local climate and the requirements of the chosen varieties.

PREPARATION FOR PLANTING A VINEYARD

Preparing the Soil.—Unless the soil of the vineyard site is unusually fertile and of good physical texture, preliminary preparation over a period of one or more years before planting the vines will prove profitable. Such preparation will consist of planting the site to a tilled crop in order to subdue the weed pests, the growing of cover crops, the application of barnyard manure, and deep plowing the fall or winter before the planting is to be done. Experience has shown that the grower will be well repaid for his expenditure of time and money in this preliminary work by the greater vigor of the vines, their larger early crops, their longer productive life, the decreased number of replants, and the lessened cost of weed control after the vineyard is trellised.

Obtaining the Plants.—American grapes are propagated by hardwood cuttings. This means that cuttings three or four buds long; are made during December or January from canes of the preceding summer's growth. These cuttings are stored until planting time the next spring and are grown in nursery rows one or two years. If cutting wood is available, the grower can propagate his own plants, but the vineyard will be delayed at least one year and the saving will be small.

The prospective grower usually plans his new vineyard well in advance of planting time and, after deciding on the varieties and number of each which will be needed, visits or corresponds with several nearby reliable nurseries asking for bids. Either one- or two-year-old nursery-grown plants may be ordered, though some experts state a preference for the younger plants. Good young grape plants have an abundant and fibrous root system. It is well to buy the vines in January, though they need not be shipped until later.

SETTING THE VINES

The best time to plant grapevines in Kansas is early spring, March or the first week in April. If the soil is in planting condition, that is, thoroughly prepared and dry enough to work without injury to its texture, the vines may be set as soon as received from the nursery. Otherwise, they should be unpacked and heeled in until a more favorable time.

Planting Distances.— Since grape varieties differ in vegetative vigor, planting distances will vary. Of the varieties previously described Worden is the most vigorous and will give highest yields when the plants are set ten feet apart each way. Concord and varieties of similar vigor are commonly planted 8 x 8 feet, and weak-growing vines such as Delaware may be set as close as 6 x 6 feet. Nine feet between rows and eight feet between plants is a rather common planting system, the wider spaces adding to the convenience of working between the rows. This is especially desirable where the Munson system of trellising is used. Too close planting is a very common error among Kansas vineyardists. It occasionally results in a few very large crops, but on the average reduces both yields and length of life of the vines and increases the cost of caring for the vineyard. Close planting is sometimes recommended on high-priced land. In general the rows should run north and south.

Plants Required for an Acre.— The number of plants needed to set an acre of grapes at the different planting distances are shown in the following table.

Set 6 x 6 feet.....	1,210 plants
Set 8 x 8 feet.....	680 plants
Set 8 x 9 feet.....	605 plants
Set 9 x 9 feet.....	537 plants
Set 9 x 10 feet.....	484 plants
Set 10 x 10 feet.....	435 plants
Set 10 x 12 feet.....	363 plants

Planting.— A common practice in planting the vines is to open up deep furrows marking the rows. A wire stretched along the furrow and marked with “bobs” at eight- or ten-foot intervals opposite which the vines are set is a convenient aid in making straight rows. One man can distribute the vines for two two-man planting crews. He is responsible for the protection of the roots from sun and wind and their pruning to equal lengths of about eight inches.

Each two-man crew should be provided with a shovel with which

a hole in the furrow is enlarged to sufficient width to receive the roots of the vine without bending, and deep enough that the top of the cutting from which the vine was propagated will, when set, be at least one inch below the surface of the leveled soil. Grapevines usually have the roots in two whorls. Those of the upper whorl should be held up by one man of the crew while the other shovels in good top soil over the spread-out roots of the lower whorl. After this soil is well compacted by tramping, the upper whorl is spread out on it in a nearly horizontal position and these are well covered with top soil which is also firmed down. Filling the furrow may be completed by the use of a horse-drawn corn cultivator or disk. Immediately after setting, all except the strongest cane should be cut off each vine and this cane should be cut back to two or three strong buds.

Arrangement of Varieties.— Many varieties of grapes yield large crops only when provision is made for cross-pollination of their blossoms. However, of the varieties described or named in this circular, only Brighton is reported as being definitely self sterile. The others appear to be somewhat more fruitful if interplanted, but will set fruit when isolated or when planted in large blocks. This enables the grower to set the plants of each variety together and thus economize in trellising, spraying, and harvesting. In case Brighton is planted it may be placed in blocks of four rows with safety if good pollen-producing varieties such as the Concord group or Delaware are adjacent to it. Some advantage may also follow from planting varieties which ripen at the same time in the same part of the vineyard.

MANAGEMENT OF VINEYARD SOILS

As previously stated, the grape will persist for many years on soils that are low in fertility and rather dry. However, high fruit yields and long life of the vines are closely related to favorable soil conditions.

Maintenance of Fertility.— There are Kansas soils which contain sufficient natural fertility to support a vineyard throughout the normal life of the plants and enable them to produce good crops. Such soils are seldom used for grapes, however, and the grower must give careful attention to the maintenance or improvement of the fertility of his vineyard soil. In localities where barnyard manure is available its application to the soil each year or in alternate years is the best method of maintaining soil fertility. It not only maintains the necessary elements of fertility but also aids in keeping the land in a good state of tilth. This last is especially important on the heavier clay soils which are difficult to work and which tend to bake following heavy rains. Annual dressings of 5 to 10 tons of good barnyard manure to the acre are usually sufficient to assure these benefits. It should be applied whenever available, but preferably during the late winter.

If barnyard manure is not available, a cover crop, especially a

legume, grown in the vineyard will accomplish much the same results. It will aid in maintaining the fertility and physical texture of the soil and will lessen erosion if the vineyard is on sloping land. A cover crop of winter vetch is illustrated in figure 2.

Cover Cropping.—The Agricultural Experiment Station vineyard is situated on a rather steep south slope. The soil is a clay loam underlaid by a heavy red clay. Neither the fertility nor the physical texture of this soil is naturally good. The plan of development called for the setting of the vines during March, 1922. In preparation for this planting the land was manured heavily in the



FIG. 2.—A winter vetch cover crop in a young vineyard. (Photographed June 23.)

spring of 1921, then plowed, and clean cultivated during the entire summer to rid it of weeds and brush. In the early fall a light dressing of barnyard manure was applied, and on September 1 winter vetch at the rate of 30 pounds per acre was planted. Rows were established and double furrows thrown out March 26, 1922, and the vines planted at once. At planting time the vetch had made a dense mat which was 6 to 8 inches thick as shown in figure 2. This method resulted in a good growth of the young plants.

A strip of vetch about 12 to 18 inches wide, in the center of each space between rows was allowed to ripen seed before being disked under early in July. The seed germinated following the last cultivation in August and produced a good cover crop. This method of cover cropping was continued each year until the summer of 1926. Because of the dry weather in April, 1926, the vetch was all plowed under late in that month and reseeded the following August. Five heavy crops of winter vetch were thus turned into the soil from one planting of seed.

Additional Cover Crops.—Rye, sown about 90 pounds to the acre, is a good cover crop for the maintenance of organic content of the soil. It is not so valuable on soils low in nitrogen as is a legume. Great care must be exercised to plow rye under before it has seriously depleted the soil moisture or plant food in the spring. Just prior to the appearance of the heads is probably the best stage for plowing during a spring of normal rainfall. If the soil is too wet to plow at that time, the rye should be mowed or disked and plowed under later. Cowpeas are an excellent tender legume cover crop for vineyards. They should be seeded in early August at the rate of 60 to 90 pounds and plowed under early the following spring. They are most efficient as a cover crop when the fall is wet and the spring is dry, a rather unusual weather combination in this part of Kansas.

Cultivation and Control of Weeds.—Maintenance of fertility and good physical texture of the vineyard soil is of primary importance, but some additional phases of this part of modern grape growing require attention. First among these is the control of weeds. From early spring until after harvest the vines demand a constant and rather liberal supply of soil moisture and plant food. If weeds are tolerated they compete, and usually successfully, for the available supply of water and dissolved minerals, to the great detriment of the vines.

Control of weeds and grasses requires cultivation. This may be well done with a variety of implements, but a reversible disk cultivator narrow enough to pass easily between the rows is one of the best. The direction in which the soil is moved can be changed for each succeeding cultivation in order to keep the surface of the land nearly level. On soils of good tilth this disking might prove to be the only machine work necessary, but frequently, especially when cover crops are grown, disking should be preceded by an annual spring plowing. This can be done best with a one-horse 10- or 12-inch plow. Some hand work to destroy the weeds under the trellises will be necessary, but the number of diskings and hoeings needed will depend almost wholly on the weed growth and should decrease in number as the vineyard becomes older and the serious weed pests are exterminated. Early cultivation to a depth of 3 or even 5 inches does no injury to the vines.

Soil Erosion.—When Kansas vineyards are situated on sloping land, which is desirable for the avoidance of frost injury, preventing erosion of the surface soil is sometimes a serious problem. On page 7 it was recommended that the grape rows run north and south. This is good general advice, but the contour of the site may make some other direction desirable. If erosion is probable the general direction of the rows should be at right angles to the slope of the land. These two desirable features can be combined on slopes facing either the east or the west, but on north or south slopes a choice must be made. If the slope is abrupt and the probability of washing rains great, the rows should run east and west on such sites.

Cover crops effectually lessen erosion by spring and early summer rains and level cultivation does much to prevent it later in the season. Such practices as building dams under the trellises or even terracing the land before planting the vines may prove profitable for the prevention of erosion. However, the system of terracing hill-sides followed by European grape growers would be far too expensive in labor costs to permit a profit in this state.

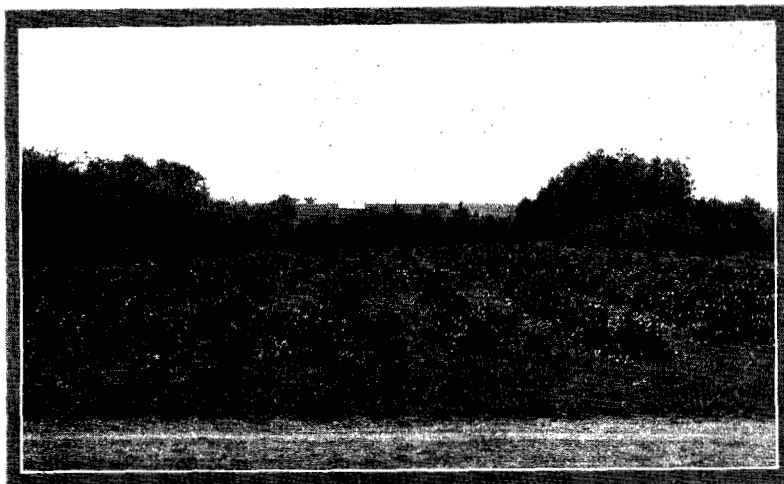


FIG. 3.—Vines in a young vineyard during their second summer. Each vine is supported by a single stake set as shown in figure 2.

TRELLISING THE VINEYARD

American grapes require a supporting trellis of some kind after they come into bearing and are benefited by being held upright during their first two years in the vineyard. Keeping the vines off the ground is beneficial in several ways. It prevents injury during cultivation, gives better exposure of the leaves to sunlight, makes possible adequate spraying of the plants, and aids in protecting the fruit and keeping it clean. Experience indicates that the vines do almost as well the first year without as with support; but, since support is desirable the second year and is necessary both years if cover crops or intercrops are grown, it seems best to set a stake by each plant soon after growth starts. This stake may be of any wood which will last two years or more and should be about four and one half feet long, and driven one foot into the ground. To it the strongest two canes should be tied each of the first two summers. Others may be allowed to grow as wind and the cultivator permit, (Fig. 3.) Permanent trellises are required for the third year's cane growth.

Types of Vineyard Trellises.— Many kinds and types of trellises have been devised, but the test of practice has reduced them

to a small number. For most systems of training a trellis similar to a fence is needed. This may have two or three wires but they all lie in the same vertical plane. The Munson system of training requires a trellis on which the wires are arranged in a horizontal rather than a vertical plane. Some suggestions regarding building of both types will be given later.

Trellis Materials.— Posts and wire are the principal materials needed for grape trellises. Posts may be of wood, iron, or concrete. (Fig. 4.) Those for the ends of the runs should be 8 feet long and interior ones 6 1/2 to 7 feet. Decision regarding the kind to use is



FIG. 4.—Four kinds of end posts. Left to right, Osage orange, catalpa, boiler tube, and concrete.

largely an economic problem and exact data on the comparative durability of posts of the various materials are not available.

Reinforced concrete posts should be everlasting. Those in the station vineyard are as good as when set 13 years ago. These posts were home-made of coarse river sand and cement in the proportion of 4 to 1. The end posts are 8 by 8 inches by 8 feet, with four 1/2-inch reinforcing rods placed one near each angle. The bases of the interior posts are 5 inches square and they taper to 4 inches square at the upper end. They are 7 feet long and have a 1/4-inch reinforcing rod near each corner. Pieces of 1/4-inch gas pipe were so placed in the concrete while it was soft that they served to receive the wires after the posts were set. Concrete should be kept out of them. Material and labor for these posts cost \$1.50 each for the larger size and 75 cents for the small size. This price did

not include the cost of forms, as these could have been used many more times.

Iron posts of two general kinds are found in vineyards of Kansas. The first of these are made of worn-out, 4-inch boiler tubes. These can sometimes be obtained for 50 cents a tube, 16 feet long, or 25 cents a post, but double these prices prevail in other sections. Fastening the wires to these posts is bothersome or, if the posts are bored for the wires, expensive. End boiler tube posts should be set in a block of lean concrete 18 by 18 inches square and 3 feet deep. So set they will require no bracing. Patented metal posts are now being used in large numbers for trellis building and have proved satisfactory in the station vineyard.

Wood posts have predominated in Kansas vineyards and probably should be used in preference to others when available. The best species is Osage orange, though catalpa, cedar, and white oak are also used. End posts should be large, at least 7 inches in diameter, but smaller sizes answer for the interior ones. Prices for these are variable but will average somewhat more than 35 cents. Fortunate is the grape grower who owns a wood lot from which he can cut posts for his vineyard trellis.

Experience in the station vineyard shows that catalpa posts are especially subject to attack by termites or white ants. The only replacement of posts necessary in the vineyard in 13 years has been catalpa posts so attacked, and one broken, interior concrete post.

Nearly all grape trellises are now built of galvanized wire, although old-time annealed wire was formerly used extensively. Wire of large diameter is recommended, as the weight on it is great toward the close of the season. Adequate sizes are numbers 9, 10, 11, and 12. These are sold by the pound and their approximate length per pound is as follows:

No. 9.....	17.24 feet per pound
No. 10.....	20.5 feet per pound
No. 11.....	26 feet per pound
No. 12.....	34 feet per pound
No. 16.....	102 feet per pound

Probably No. 10 wire is most commonly used. It is 0.135 inch in diameter and will withstand a heavy load of vines and strong winds. Each 100 feet of a three-wire trellis will require 14.6 pounds of No. 10 wire, no allowance being made for brace wire at the ends of the runs. An acre of grapes set 9 feet between rows will require approximately 710 pounds, 14,555 feet, of No. 10 wire for its 4,840 feet of three-wire trellis, or one third less if a two-wire trellis is built. If the trellis wires are tied to the interior posts, No. 16 wire is sufficiently heavy for the purpose.

Staples used in building trellises with wooden posts are 1 or 1 1/2 inches long, depending on the hardness of the posts. The shorter size is used for oak and Osage orange posts, and the longer ones for softer woods. For an acre of three-wire trellis 9 to 12 pounds will

be needed. Other materials used are braces and short brace stakes to anchor end posts, and cross-arms for the Munson trellis.

Building the Trellis.—Trellis runs should not be more than 400 feet long because of the strain on the end posts and wires and convenience in working among the vines. The distance between posts varies with the distance between vines. Usually it is twice the planting distance, thus bringing two vines between each two posts. If the posts and wires are strong enough, three vines between each two posts is permissible.

Holes should be dug for the end posts, but interior posts may be driven in loose soils. End posts should be set thirty-six to forty inches in the ground and interior ones about twenty-four inches. This will leave them five feet above ground.

The end posts should be firmly braced and the wires drawn taut and under even tension. They are passed through or around end posts and are fastened to interior ones on the windward, *i. e.*, the south or west side. Staples should not be driven so close as to bind the wire to interior posts. Wire-tightening devices placed on one end post of each run of trellis are a convenience.

Many methods of bracing or anchoring the end posts of grape trellises are used. Among the best are the two illustrated in figure 5. One of the most commonly used methods is shown in (A), figure 5. The first method involves the use of two posts per row more than the other but has proved its worth under trying conditions. The horizontal brace (figure 5A) is 4 x 4 fir, but native poles could be used for this as well as with the other types of brace.

Spacing of the wires on the posts varies with the different types of trellises. Common distances for the three-wire fence trellis are: bottom wire 20 inches from the ground, middle wire 18 inches above the lowest, and upper wire 18 inches higher or 56 inches from the ground. If only two wires are used the bottom one may be 26 inches from the ground and the top one 46 inches. These heights may seem low, but a high trellis exposes the vines to greater wind injury. The Munson trellis has the lower wire 36 inches from the ground and the other two 6 inches higher and 12 inches to the left and right.

Cost of Trellises.—Trellises are the most expensive item in the development of a vineyard. Inquiries sent to a number of Kansas growers regarding their trellising costs brought widely different answers. One grower who placed his costs at \$50 an acre probably cut the posts on his farm and made but small labor charges as wire and staples alone cost between \$35 and \$40. The highest cost reported was \$290 per acre, but this probably included all costs of developing the vineyard up to the first crop. These reports averaged \$155 per acre. This is too low when all materials and labor are included at actual values. An allowance of \$200 an acre would not be wide of the mark. If concrete posts are used the cost will be higher, and a Munson trellis made of the same material is slightly more expensive than other types.

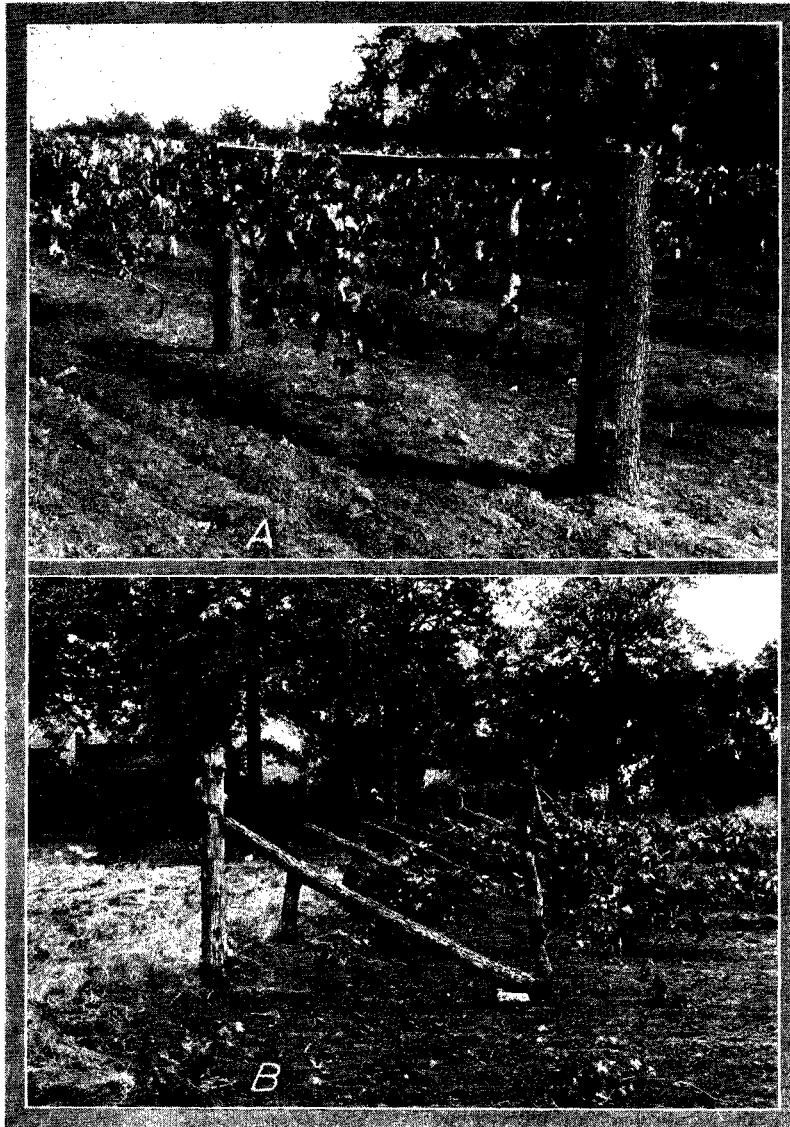


FIG. 5.—Two methods of bracing end posts. (A) Method used in the vineyard of the Agricultural Experiment Station. (B) A method often used. (The flat stone under the lower end of the brace delays its decay.)

THE ART OF PRUNING AND TRAINING GRAPES

Pruning and training are distinct, though closely related, vineyard operations. Pruning is the removal of excess wood from the vines, while training is the disposition on the trellis of the remainder. In pruning, the parts of the vine left unsevered must be located to fit the system of training used, but, the amount of bearing wood left on the pruned vine will be the same whatever system of training is followed.



FIG. 6.—Early spring growth of a grape shoot. It is at this stage that frost injury is so destructive to the grape crop.

Habit of Growth of the Grape.—The grape's habit of growth and of bearing fruit should be understood before pruning is undertaken. Cultivated grapes produce a cane of indeterminate length each year and, under favorable conditions, this growth is greatly in excess of the amount needed by the vine for the best fruit production the following summer. That a large part of each year's new growth must be removed from the vine through pruning is thus the first principle underlying this art.

The second basis relates to the fruit-bearing habit. New buds are produced in the axils of the leaves. (Fig. 6.) These are com-

plex in that they contain the rudiments of both the new shoots and the blossom clusters which will later appear on them and, also, there are two or even three growing points in each of the over-wintering buds or eyes. If the first growing point to start is frozen, another will push out a new, but weaker, growth. Shoots from these secondary embryos are much less fruitful than those from the primary



FIG. 7.—This photomicrograph illustrates the structure of a grape bud in midsummer. Inner bud scales and the embryonic shoot are shown. The small protuberances on the shoot are the primordia of future leaves, blossom clusters, or tendrils.

ones. Frequently the shoots from the lowest one or two buds on a cane produce no blossom clusters. On the Concord the best yields come on shoots six to ten, counting from the base of the cane, but this rule does not hold for Worden, and possibly not for other varieties.

The time of initiation and the later development of the buds or eyes of the Concord grape in the station vineyard have been studied two seasons. These studies show that the first stages of floral growth can be observed under the microscope early in July and that the development is rapid for four to six weeks, after which it becomes very slow, even though growing conditions are favorable. During the period October to March the buds are dormant and show no structural changes. Growth is rapid from March 1 to early May when the shoots show their first leaves and blossom clusters as illustrated in figure 6. Figure 7 is a photomicrograph of a longitudinal section of a primary bud in a Concord eye collected July 8. These studies emphasize the importance to the grape of liberal supplies of soil moisture and nutrients during midsummer and early spring. It is also of interest that the buds demand but little sustenance during the time when the vine is ripening its fruit.³

Varieties of grapes vary widely in their normal wood growth and bearing capacity. This affects the pruning. Vigorous and productive varieties such as Worden may properly retain many more buds when pruned than weak varieties such as Delaware or even Moore Early. This is all closely related to the local soil and climatic conditions, and each vineyardist must discover by personal study the correct number of buds to leave on his vines. Excessive cane growth indicates less close pruning, whereas weak wood growth and small berries on the branches indicate the need for heavier pruning, and the leaving of a smaller number of eyes for shoot and fruit production. A vine which is producing a crop of fruit will make much less cane growth than a nonproducing one. Vigorous, healthy vines properly pruned will, barring accidents, produce a crop every year.

Parts of a Grapevine.—Definite names have been given to the different parts of grapevines, and a description of pruning is more easily understood if the writer and the reader agree regarding these names. Underground parts are roots or the root system. The main stem above the roots is the trunk. It may be very short or may reach to the top wire of the trellis. A branch from the trunk if more than one year old is an arm. All one-year-old wood on a vine is called canes, or, if cut back to fewer than six buds, spurs. While a cane is growing it is called a shoot. The fruit clusters and leaves are borne on shoots and a shoot becomes a cane when it sheds its leaves. Tendrils grow on shoots opposite the leaves, but adhere and function in a mechanical way on canes. They are also called curls. Water sprouts are vigorous, unproductive shoots which start from the trunk, while suckers are vigorous shoots arising from below the surface of the soil. Figure 8 will assist in identifying these parts of a vine.

3. These studies were made by graduate assistants John A. Andrew and Chris R. Bradley.

Time of Pruning. — Practically all pruning of grapevines should be done during their rest period. This period extends from leaf fall in October or November to the swelling of the buds the following March. Probably December, January, and February are the best months for this work, and all equally good. Early winter pruning, if followed by winter injury, may result in too few buds for the production of a full crop. Too late pruning results in “bleeding” of the canes which, though undesirable, is not very injurious, and in breaking off of buds, which is very harmful. General summer pruning is not profitable under Kansas vineyard conditions, but heading back shoots that are going beyond the vine’s share of the trellis is worth-while spare-time work.

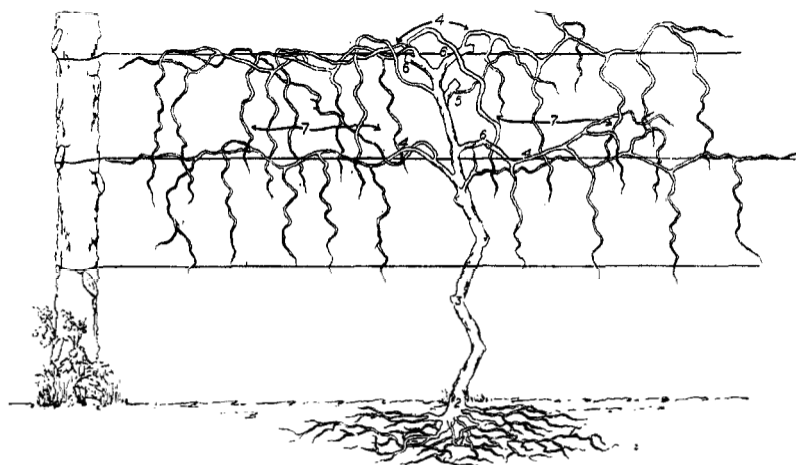


FIG. 8.—A diagrammatic outline of a grapevine with leaves removed. The parts are: (1) Roots; (2) crown; (3) trunk; (4) canes; (5) spur; (6) arms; and (7) shoots.

Pruning Young Vines. — Directions for pruning grapevines at setting time were given on page 8. As a rule they need no further pruning until the following winter, when they are again so pruned as to prevent fruit bearing during the second year; that is, the canes are all removed except the strongest one and it is cut back to two or three strong buds. Exceptionally strong vines may be allowed to retain, on one cane, 10 to 15 buds and thus produce a light crop the second year.

Following the second summer’s growth in the vineyard the vines are approaching maturity and may be pruned in such a manner that they will bear a light crop of fruit the third growing season. Actual practice is again to cut away all except the strongest cane on each vine. If the vine is of good vigor this cane is headed back at the height of the top wire of the fence trellis or somewhat above the lowest wire of a Munson trellis. From 10 to 15 productive eyes will

be the right length. Weak vines should retain fewer eyes, and very weak ones and replants should again be cut back to two or three buds.

Pruning Mature Vines.—The actual work of pruning mature grapevines is much more simple and easily understood than is that of pruning fruit trees. This is true because a definite system of pruning and a standard form for all the vines is adopted and every normal vine is so pruned that it conforms to this standard. Fruit trees cannot be so managed under American orchard conditions. With both kinds of fruit, each plant is an individual problem, but the solution is much easier with the grape because by far the larger part of the wood on the plant is removed every year.

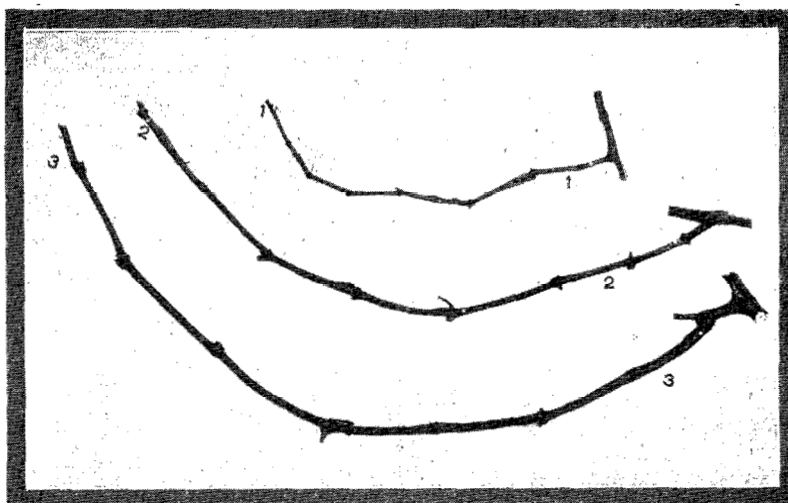


FIG. 9.—Types of cane growth cut from the Concord vines shown in figure 5A. Cane 2, of medium vigor, is considered the best type of fruiting wood.

The number of bearing eyes which should be left on a pruned grapevine varies with the variety and the vigor of the individual plant. This has, finally, to be determined by the grower for his own vineyard, as the local climatic and soil conditions exert a strong influence. The natural tendency of grape pruners is to prune too lightly, to leave too many eyes on a vine, and, as a consequence, have an alternation of heavy and light crops and sometimes badly weakened vines. The less vigorous varieties, such as Moore Early, should be pruned to about 30 buds distributed on two or more canes. Concord can mature its fruit fairly well when as many as 50 buds are left on a vine, but it cannot at the same time produce strong bearing wood for the succeeding crop. For the majority of vigorous Concord vines, 35 to 40 buds will be the best number. Some of the more vigorous varieties, such as Worden and Lucile, can produce

both good fruit and good wood growth from as many as 45 buds if on fertile, well-watered soil and given good care.

Distribution of the buds left on the pruned vine will depend on the system of training adopted. Usually they will be nearly equally divided among either two or four canes. Figure 9 illustrates three types of cane growth. Each cane is eight buds in length. There is evidence that wood of medium vigor as shown in cane 2 is the most productive.

The Labor Involved.— The labor of pruning a vine can be described under three headings; namely, blocking out, cutting curls, and stripping. These three operations may well be done by a squad of two or even three men. The leader, who must have technical knowledge of grape pruning, will "block out" the vines. This consists (1) in selecting the canes which will be left on the vine for fruit bearing and the spurs, if any, for wood production and cutting them off at the proper length, and (2) the cutting loose from the vines, but not from the trellis, of all other cane growth. The second step is cutting all the wood of the vine loose from the trellis. It includes severing the old ties as well as the curls. Third comes the stripping of the severed wood from the trellis. One or two helpers may cut curls and strip off the canes. They must be taught to avoid injuring in any way the parts which are to remain on the vine.

Renovation Pruning.— Although the trunk and arms are called permanent parts of a grapevine, it is sometimes good practice to remove them at pruning time. If, because of their annual extension, the arms have become so long that they spread over a wide part of the vine's share of the trellis, and will not produce shoots close to the head of the trunk, their removal is advisable. Whole trunks which have become unmanageable or infested by borers should be cut off. One crop will be lost by these treatments, but the future yields will be increased.

The brush should be removed from the vineyard and burned soon after pruning is completed.

A pair of hand shears of some good make and of medium weight is the principal tool needed in pruning grapes. Occasionally when an old arm or a trunk requires removal a saw must be used. One should always be carried while working among old vines.

TRAINING SYSTEMS

Long Versus Short Pruning Systems.— All the systems of grape training mentioned in this discussion require what is known as long pruning; that is, the canes on which are left the buds for bearing-shoot production always carry more than five buds after pruning. If cut back to fewer than six buds the system is known as short pruning, even though the total number of buds on the vine remains the same.

The advantages of long-cane systems of pruning over the short-cane, European systems, are well shown by the results of demonstration work done under the supervision of W. R. Martin, Jr., ex-

tension horticulturist, in four Kansas counties; viz., Wyandotte, Shawnee, Doniphan, and Jefferson. In each of these seven tests ten Concord vines were pruned to conform to each of the following systems: Four-cane Kniffin, two-cane Kniffin, short fan, and spur. Each vine carried forty buds after being pruned, so there were ten buds to the cane on the four-cane Kniffin vines and twenty buds on each cane of the vines pruned to the two-cane Kniffin system. The vines pruned to the short-fan method bore eight canes, each five buds in length. This constituted semishort pruning. The short or spur-pruned vines each carried thirteen three-bud canes or spurs. In every one of these tests the long-pruned vines yielded more fruit than the vines pruned to the short-fan or the spur system. Average yields are shown in Table I.

TABLE I.—AVERAGE YIELDS FROM LONG-PRUNED AND SHORT-PRUNED CONCORD GRAPES

PRUNING SYSTEM.	Number of bunches per vine.	Average yield per vine.
Four-cane Kniffin.....	70.0	Lbs. 10.48
Two-cane Kniffin.....	74.7	11.99
Short-fan.....	56.4	7.45
Spur.....	43.2	5.35

Experimenters in other states have obtained similar results when the production from long-pruned vines was contrasted with that of adjoining vines pruned to short canes or spurs.

The Four-Cane Kniffin System.—One of the oldest and best long-pruning systems for Kansas vines is the four-cane Kniffin. In preparation for this system one cane is carried to the top wire of either a two-wire or three-wire trellis when the vines are pruned prior to the third year's growth in the vineyard. This constitutes the permanent trunk of the vine. Each subsequent year four bearing canes arising from or close to this trunk are left and are tied to the top and middle wires in the form of a cross. Since the upper pair are better nourished than the lower, they carry a larger number of buds. A good distribution of buds for this system, on Concord vines of average vigor, is ten to each upper cane and six to each lower cane. Spurlike canes bearing two buds each may be left on the trunk near the wires to produce fruiting canes for the next year, but good shoots from the current season's bearing wood will be equally valuable if not too distant from the trunk. Figure 10A illustrates a young vine pruned according to this system.

The Two-Cane Kniffin System.—The two-cane Kniffin system is a modification of the four-cane system, in which the lower pair of canes is dispensed with and the upper pair carries all the buds. It

GRAPE GROWING IN KANSAS

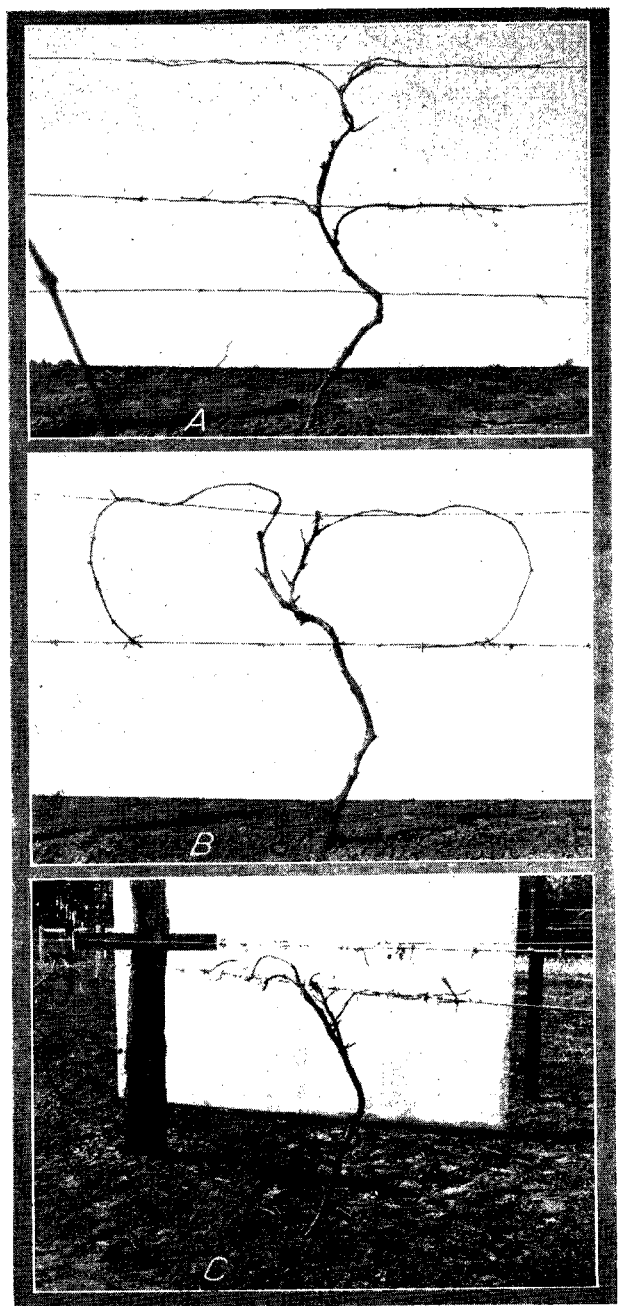


FIG. 10.—Grapevines pruned and trained according to different systems. (A) The four-cane Kniffin system. (B) The two-cane Kniffin system. (C) The Munson system.

is also called the umbrella system because the form in which the canes are tied is similar to two opposite ribs of an umbrella. A two-wire trellis is frequently used for this system, but three wires are better, especially in sections of strong winds. A vine pruned and trained according to this system is shown in figure 10B.

The Munson System.—The Munson system, or any modification of it, is a canopy system of grape training. This means that the wires are in a horizontal instead of a vertical plane and that, as a consequence, the shoots grow at right angles to the line of trellis in the form of a canopy or arbor. (Fig. 10C.) The trellis for one form of this system is described on page 14. After pruning, the canes are tied to the middle or lower wire and the shoots as they grow attach themselves to the two upper and outer wires. All the fruit is borne under the canopy of leaves so formed and between the middle and outer wires. Advantages of this system are: better protection of the fruit from both birds and sun scald; spraying made more effective and easier; fungous attacks lessened because of better ventilation around the fruit; and greater convenience in harvesting. Increased cost of trellis and wider planting necessitated by the cross arms are distinct disadvantages. Usually two canes with about nine buds each are tied in each direction on the middle wire, or when the vines are planted far apart one cane bearing fifteen or twenty buds may be used in place of two.

The three systems of training described are all known to be adapted to Kansas conditions and are about equally recommended.

They are all drooping as well as long-pruning systems. Others of the same type are the fan system, especially adapted to half-hardy varieties, and the two-trunk-four-cane Kniffin system. These also have their friends and will give good results when properly used. Short-pruning systems should be avoided because of the reduced crop which they yield, and also high trellised systems, *i. e.*, above five feet, because of wind injury.

TYING GRAPEVINES

The trunks and canes of grapes must be securely tied to the trellis properly to expose the leaves and fruit to air and sunshine and to protect the vine from destructive winds and injury by implements used in cultivation.

Tying Materials.—Many different materials are used for tying in the vineyard. Among these are sisal and hemp twines, rag strips, raffia, bark, and withes. Whatever is used must be strong enough to stand considerable strain and enduring enough to last through the entire growing season. The trunk is sometimes fastened to the lower wires of the trellis by a light-wire loop, which will not require renewal for a number of years.

The Time and the Operation.—Tying should be done soon after the pruning is completed. Wind may injure loose canes, and if delayed until the buds start growth many of them will be rubbed off to the great detriment of the crop.

Correct practice in the operation of tying is important. If the knot is improperly made, the tie will slip and the cane will not be held in its proper place. A square knot is the proper kind to use, except, of course, in tying with withes.

In windy regions, some summer tying of shoots is of great aid in keeping the vine properly placed on the trellis. The regular distribution of the shoots on the Munson trellis is assured by summer tying, and shoots of the vines trained to Kniffin systems can in this way be kept in a drooping position. The trunk of the vine should be tied to the south or the west side of the trellis.

HARVESTING AND PACKING GRAPES

Grapes for the market must be so harvested and packed as to make them attractive to purchasers. This involves good color, good quality, and a neat, clean package of desirable size.

Yields from Kansas Vineyards.—Few other fruits respond so quickly and fully to good care as does the American grape. This character leads to danger because an excessive crop may greatly weaken the vines and shorten their productive life. Yield in Kansas is reported in the 1932 census as only 2,368 pounds to the acre or about 4 pounds to the vine, and 1932 was a good grape year. The better vineyards of the state give much higher yields. About 3 tons to the acre is a good crop of Concords and could be maintained over a long period in a region having adequate rainfall. Table II shows yields in the vineyard of the Agricultural Experiment Station at Manhattan over a five-year period. The vines were planted in 1922, except Lucile, which was planted in 1925.

TABLE II.—COMPARATIVE YIELDS OF GRAPE VARIETIES

Pounds per acre; Manhattan, Kan.

VARIETY.	1926.	1927.	1928.	1929.	1930.	Average.
Moore Early.....	4,604	6,201	1,603	3,040	3,570	3,804
Concord.....	5,449	5,944	5,360	7,650	4,777	5,836
Worden.....	4,998	5,912	6,168	7,257	4,683	5,804
Niagara.....	2,036	4,384	4,719	6,897	1,300	3,867
Lucile.....		2,282	681	7,053	7,462	3,496

Time and Method of Harvesting.—Since grapes do not improve greatly in flavor or aroma after they are taken from the vine, they should be allowed to become nearly ripe before harvesting. When ready to pick they will have their full color, will be rich in sugar, aromatic, and the stem of the bunch will begin to show brown areas. After one learns the taste of the different varieties when ripe he has available the best guide to correct time of picking for dessert use or for making grape juice. If intended for jelly making, grapes

should be harvested earlier. Black varieties will have the most mature berries turning black and the remainder red when at the jelly stage. If picked too early the yield is decreased, and if allowed to become too mature the jelly is too dark and will contain undesirable crystals.

Ripe grapes should be clipped from the vine with quick-acting light shears. The bunch is handled only by the stem when practicable and placed gently in the basket. The baskets of grapes should be placed in the shade of the vines at once after being filled. Grapes should not be harvested while they or the vines are wet. Figure 11 illustrates grape picking as practiced in a small commercial vineyard.



FIG. 11.—A picking scene in a small vineyard. Picking shears and a basket carrier are illustrated.

Containers for Grapes.—Dessert grapes are packed and sold in climax baskets of various sizes. Laws of various states are conflicting regarding the standard containers for grapes. Those intended for juice factories are usually transported in large baskets or in open lug boxes.

Climax baskets for the market should have the bunches of grapes so arranged in them that the space is snugly filled and that the stem of the bunches forming the top layer do not show. This packing may be done by the pickers in the vineyard, but can be done better as a separate operation in the packing shed. Clean baskets well packed with sound, ripe grapes sell much more easily than a poorly handled product.

Storing American Grapes.—American grapes, if picked just before they are ripe, wilted for a few hours, and then placed in good storage, will keep several months. The commercial crop is held under cold storage, but growers may keep fresh grapes for several months in properly managed air-cooled storage. Only perfectly sound grapes should be stored. These should be placed in thin layers in trays and cooled to 50 degrees or lower as soon as possible after picking. They are then placed in a room or basement where the air humidity is medium and the temperature can be held near the 40-degree mark. Too dry storage will cause the berries to wilt; too moist storage causes mold. The nights of Kansas autumns are sometimes too warm to allow successful cooling of air-cooled common storages.

USES OF GRAPES

Dessert.—The best use to which the American grape is put, from the grower's standpoint, is to eat it raw as dessert or otherwise. When so used it brings the best price and is of the greatest dietary value. Greater care in picking, grading, and packing and better organized marketing would probably enable Kansas growers to sell a larger part of their grapes for this purpose.

Jelly.—Grapes picked at a preripe stage are used in large quantities for jelly making. The grower who harvests his crop to meet this demand avoids some hazards to which fruit allowed to ripen on the vine is exposed, but will obtain a smaller yield and, sometimes, a lower price per pound. Harvesting part of the crop at the jelly stage is frequently good management.

Grape Juice.—Great quantities of grapes of the Concord type are utilized in the making of grape juice. Fortunate is the grower whose vineyard is located near a grape-juice factory. He has a third market for his product. Grape juice may be made successfully in the home, both for use by the family and for sale. United States Farmers' Bulletin 1075, is a manual for the home preparation of unfermented grape juice and should be in the hands of every grape grower. Grapes are also made into jam, butter, and marmalade.

MARKETING KANSAS GRAPES

Many growers of grapes in Kansas can sell their product to consumers at the vineyard or through local stores. If on a highway, sales stands may prove profitable. The growing of a high-quality grape, its careful grading, and attractive sales packages add to the grower's profit. This is especially true when these points are stressed year after year. The effect is cumulative as the buyers gain confidence in the grower's fruit. Dessert grapes and those intended for juice making or culinary uses should be in different, packages, those for the second group of uses being much larger.

Grapes intended for sale on the general market where they come in competition with those grown in other districts must be handled with great care and must be packed in containers which meet the

demand in consuming centers. With these, well organized cooperative marketing will prove more profitable than individual selling. The associations at Wathena and Blair handle large quantities of Kansas-grown grapes. It probably pays commercial grape growers to exhibit fruit at fairs and shows within their trade territory.

INJURIOUS INSECTS

A rather long list of insects may at times become injurious in the vineyard. Since several of them are primarily pests on other plants, the location of the vineyard with reference to the apple orchard and the bramble patch, especially the raspberry, has an influence on the appearance of such insect pests as the cane borer and the leafhopper.

Cane Borer. — The cane borer, when it attacks grapevines, usually eats its way into the cane, starting from the axil of a leaf. It then follows down the center of the cane, which dies. Entire vines may be killed by the attack of a number of the beetles. Control measures consist in watching carefully for this insect's work during summer and fall, and removing and burning all infested canes.

Flea Beetle. — The flea beetle is a small blue-black insect which feeds on the buds and later the leaves of grapes in the early spring. Buds attacked by this pest do not develop, so the whole shoot and its fruit is lost. Clean culture and arsenate of lead spray applications will control the flea beetle.

Leaf Hopper. — These are small, white to yellowish, sucking insects which infest the lower side of grape leaves. The adults are very active but the young cannot leave the leaf on which they are feeding. Control of this injurious pest is readily effected by spraying the lower surface of the grape leaves with sulphate of nicotine as soon as injurious numbers of the young hoppers appear, and before their wings develop, usually just before midsummer. Their work is readily detected by the loss of green color in small spots distributed over attacked leaves.

Leaf Folder. — The grape leaf folder frequently does considerable injury in Kansas vineyards. The caterpillars are greenish white in color and about one inch in length. The principal brood appears in midsummer. Each young caterpillar fastens the edges of a leaf together over itself and is thereafter protected in its feeding. Arsenate of lead spray must be applied before the leaves are folded if this insect is to be controlled.

Fidia or Grape Rootworm. — The adult of the grape rootworm is a small, grayish brown beetle which appears in early summer and feeds on the upper surface of the leaves. It makes characteristic, chainlike holes in the leaves. The eggs which are laid on the bark of the vine hatch into grubs which enter the ground and feed on the roots of the plants. It is here this insect does its principal damage, even killing the plants outright when the infestation is heavy.

Figure 12 illustrates the work of the adult insect on a grape leaf. The grape rootworm can be controlled by spraying with arsenate of lead. The addition of two gallons of cheap molasses to each 100 gallons of spray mixture greatly increases its efficiency. Clean cultivation in the early spring destroys many of the overwintering larvae of this insect. Near-by oak trees increase infestation.

Grape Curculio.—The grape curculio is a small, brown snout beetle which injures both the leaf and fruit of the grape. The



FIG. 12.—A grape leaf destroyed by the adult grape rootworm.

adults begin feeding on the leaves in May. About a month later the eggs are laid beneath the skin of the grape berries, where the larvae feed for about two weeks and ruin the fruit. Regular spraying with arsenate of lead, and clean cultivation of the vineyard will control this pest.

Grape Berry Moth.—Injury by the grape berry moth consists in the destruction of blossoms and fruit by the larvae. Nearly all wormy grape berries are the result of attack by this insect. It corresponds to the codling moth of the apple. The caterpillars appear from June on, there being three broods. Thorough spraying with arsenate of lead according to the schedule on page 31 will minimize damage by this insect.

Rarely will all of these insects be present in one vineyard in Kansas, but all of them become destructive at times in some part of

the state. A number of other insect pests may on occasion become injurious in Kansas vineyards. Among these phylloxera, rose chafer, aphid, scale, and climbing cutworm deserve mention.

GRAPE DISEASES

American grapes when grown in Kansas are comparatively free from injurious diseases. Only two are commonly met with and serious injury from them can be prevented by the application of Bordeaux mixture sprays.

Black Rot.—The fungous disease known as black rot is found in all parts of Kansas and is the most injurious of the diseases attacking the grape. It infects all parts of the vine but is most destructive on the fruit. It first appears on the half-grown berries as small whitish spots. A brown ring soon appears around the margin of this spot and extends until the whole berry rots and dries up to a wrinkled, black mummy. Leaf infections first appear as irregular light-brown spots with darker margins. The spores causing this disease require water for germination but the fungus develops most rapidly during hot, dry weather. Bordeaux mixture spray will keep this disease in check if thoroughly applied and properly timed. Powdery mildew is controlled by the use of the same spray material applied upon the first appearance of the disease.

Other Diseases.—Other less important diseases of the grape in Kansas are the downy mildew and anthracnose. These rarely become destructive if the ordinary spray applications are made. A dormant lime-sulphur spray, one-to-eight strength, is recommended for anthracnose control in addition to the summer sprays of Bordeaux mixture.

Birds and boys are sometimes vineyard pests which are difficult to control.

SPRAYING

Grapes grown in Kansas are less subject to injury by pests than are the tree fruits. However, spraying is a necessary part of the care of a commercial vineyard and must be prepared for well in advance of the opening of the spray season.

Spraying Equipment.—On a general fruit farm the vineyard can be sprayed with the outfit used for the fruit trees, provided the rows of grapes are not too close together. If the spray outfit is purchased primarily for the vineyard it may be of smaller size and capacity than for orchard work. Hand spraying, in which one workman covers the upper surfaces of the vines and one the lower, is superior to that done by fixed-nozzle spraying. A hand-power spray outfit will be adequate for vineyards up to one acre in size.

Spray Schedule.—Experience in the station vineyard indicates that a spray schedule for grapes should be varied from year to year to fit the attacks of the pests. During some seasons only a full schedule of sprays will serve to protect the plants and fruit while, on rare seasons, they might come through unharmed even though no spraying were done. Only the grower who is thoroughly familiar

with the various pests and makes frequent careful observation trips through his vineyard can risk the omission of spraying. Commercial vineyards should always be sprayed.

1. A dormant spray of lime sulphur (1-8) may be applied before the buds open. If neither scale nor anthracnose be present in the vineyard, this spray is unnecessary.

2. If an attack of the flea beetle occurs an arsenate of lead spray should be applied as soon as the pest is discovered.

3. The third spray should consist of 3-6-50 Bordeaux mixture to each 50 gallons of which 2 pounds of arsenate of lead have been added. It is applied when the second or third leaf shows on the shoots and is for the control of the fungous diseases. Should no chewing insect be present the arsenate of lead may be omitted from this spray.

4. The fourth spray named here, and which is frequently the first applied in well-cared-for vineyards, is of the same material as No. 3 and applied soon after the blossoms have fallen. It serves to combat the diseases and any chewing insects which may be present.

Subsequent sprays are sometimes needed at intervals of 10 days or two weeks, for which the same materials are used, except that the presence of the grape rootworm will call for the addition of molasses, and the presence of the leaf hopper the addition of 1/2 pint of sulphate of nicotine to each 50 gallons of spray liquid. Directions for the preparation of home-made Bordeaux are found in Kansas Circular 169, or may be secured upon request from the Agricultural Experiment Station, Manhattan, Kansas.

THE HOME VINEYARD

The care of a home vineyard differs but little from that of a commercial one, but a few points of divergence should be called to the attention of those wishing to grow grapes for their own use. Varieties of higher quality, such as Delaware and Brighton, may be planted in addition to Worden or Concord. If the grower is really interested in his home vineyard he will find it pays to give it intensive care, more intensive than would be profitable were the fruit being grown for market.

Special operations are winter protection of the canes of tender varieties, close planting made possible by the application of fertilizers and irrigation water, and special care in training the shoots or doing summer pruning. Other intensive but noncommercial practices, such as ringing canes, heating the vineyard as protection against frost, bagging bunches of fruit to protect them or to enable them to hang longer on the vines, grafting the common varieties on especially strong root systems, arbor training of the vines, and even the production of European varieties under glass add greatly to the amateur grower's interest and pleasure. Lacking the time for these refinements he may yet secure a home supply of this fruit with the minimum of effort. Their culture is recommended to any home owner who has land for a few grape vines.

SUMMARY

The American grape is easy to grow and is adapted to selected sites in all parts of Kansas where the soil moisture is adequate.

For most sections of the state, Concord should be the leading variety but in home vineyards, varieties of high dessert quality may be substituted in part for the Concords.

Yields of grapes are closely related to the fertility of the soil of the vineyard and the culture given it.

Correct pruning is essential for successful grape growing and varies only in amount when applied to different varieties or individual vines.

Accurate data regarding the comparative value of popular methods of training grapevines are not available. Either of the Kniffin systems or the Munson system appears safe to use.

Loss frequently results from tardy or careless tying of the canes of pruned vines. "Tie promptly and use only square knots," should be the slogan.

Color is not a safe guide as to time of harvesting grapes for dessert use or for grape juice. They should have high sugar content for these uses.

Vigilance in guarding grapes against insect and fungus enemies is necessary. "Prevention" is the watchword.

Special treatments such as girdling or ringing, bagging, winter protection, and summer pruning are practices adapted to amateur rather than commercial vineyards.

Kansans should both grow and consume many more grapes than they have in the past.

PUBLICATIONS ON HORTICULTURE

Other publications of the Agricultural Experiment Station on horticulture available for distribution at the present time (August, 1935) include the following:

Bul. No.

HORTICULTURE

- 254. Growing an Orchard in Kansas. By R. J. Barnett. (48 pp., 13 illus.)
- 268. Control of the Codling Moth in Southern Kansas. (29 pp., 6 illus.)
- 267. Lawns in Kansas. By J. W. Zahnley & L. R. Quinlan. (32 pp., 14 illus.)
- 270. Hardy Trees and Shrubs for Western Kansas. (81 pp., 17 illus.)

Circ. No.

- 64. The Home Vegetable Garden. By M. F. Ahearn. (8 pp., 2 illus.)
- 140. Tomato Wilt Disease. By R. P. White. (5 pp., 1 illus.)
- 153. Pruning Fruit Plants. By R. J. Barnett. (28 pp., 8 illus.)
- 162. Strawberry Growing in Kansas. By R. J. Barnett. (14 pp., 5 illus.)
- 169. Spraying Fruit Plants. By W. F. Pickett and G. A. Fillinger. (34 pp., 20 illus.)
- 172. Growing Tomatoes in Kansas. By W. B. Balch. (14 pp., 4 illus.)
- 174. Commercial Fertilizers for Potatoes in the Kaw Valley. (12 pp., 1 illus.)

Copies of any of these publications in which the reader may be interested may be secured as long as available by addressing a request to: AGRICULTURAL EXPERIMENT STATION, MANHATTAN, KAN.