Grape Growing in Colorado

GEORGE BEACH AND L. R. BRYANT
Colorado State College
COLORADO AGRICULTURAL EXPERIMENT STATION
Fort Collins, Colorado

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Grape Growing in Colorado
GEORGE BEACH AND L. R. BRYANT

OVER COLORADO as a whole, grape production has never been a commercial success. The factors primarily determining this have been unfavorable soil and climatic conditions and late maturity. Commercial production is limited to the warmer and more protected counties in the State. These include Mesa, Delta, Garfield, Crowley, Otero, Montezuma, Fremont, Montrose, Pueblo, Boulder, and Jefferson Counties. Most of the grapes grown are of the native or American type, with European grapes being produced in a small way in a few locations on the Western Slope. However, even here both types may require special care and winter protection. American-type grapes are used as fresh fruit for preserving, and in the manufacture of unfermented grape juice. European grapes, while primarily wine and raisin grapes, are also used as fresh fruit. Much of the Colorado demand for American grapes is satisfied by the shipment into the State of Concord grapes a few weeks before the local fruit is ready for market. Large quantities of this fruit are used for home canning and jelly making.

Soil
Grapes can be grown on a wide range of soils, but the most desirable type is deep, well-drained, porous, and warm. Gravelly clays or sandy and gravelly loams of moderate fertility are preferable to clays or fine sands. Soils underlaid with a hardpan close to the surface, very thin or very heavy soils, or those high in lime are not good soils for grapes.

Preparation of the Soil
Since a vineyard planted on suitable soil is likely to outlive the one who plants it, preparation of the soil before planting should be thorough. Land to be set in grapes should be cultivated for at least 1 year before setting. Well-rotted manure or a green manure crop, or both if possible, should be turned under. The fields should be both fall- and spring-plowed, and the entire area should be in excellent physical condition when the vines are planted.

Selection of Plants
Grape vines should be carefully selected; only well-grown, heavily rooted plants should be set out. The plants listed in nursery catalogs as 1-year No. 1, or 1-year extra, are best.

1 This is a revision of Colorado Agricultural Experiment Station Bulletin 424.
Propagation

Few growers can afford to propagate their own plants at the prevailing prices of first-class nursery-grown stock; therefore propagation methods will not be discussed in this bulletin. Information on growing plants is given in Colorado Agricultural Experiment Station Bulletin 468, "Propagation of Plants," which may be obtained free from county extension agents or from the Experiment Station.

Varieties

Because of the wide variations in climate and soil found in Colorado, only general recommendations as to varieties can be made. Many varieties are not adapted to very alkaline soils and if planted on such soils will soon become chlorotic; that is, the foliage will turn yellow and the plants will not make satisfactory growth. Concord and a number of other common grape varieties react in this way. Extensive tests with more than 40 varieties of American grapes carried out by the Horticulture Section of the Colorado Agricultural Experiment Station have shown wide variations in susceptibility or resistance to this type of chlorosis. These varieties have been classified according to their resistance or susceptibility to chlorosis as is shown in table 1.

<table>
<thead>
<tr>
<th>Group 1. Chlorosis-resistant or nearly chlorosis-free</th>
<th>Group 2. Light to medium chlorosis</th>
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<td>Ontario**</td>
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<td>Delaware**</td>
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<td>Herbert</td>
<td>King</td>
<td>Sheridan**</td>
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<tr>
<td>Portland**</td>
<td>Wilder</td>
<td>Concord**</td>
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<tr>
<td>Salem</td>
<td>Winnell</td>
<td>Niagara**</td>
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<tr>
<td>Urbana**</td>
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<td>Regal</td>
</tr>
<tr>
<td>Agawam**</td>
<td>Goethe</td>
<td>Ives</td>
</tr>
</tbody>
</table>

* Taken from Colorado Farm Bulletin, Vol. III, No. 1, 1941.
** These varieties are suitable for home planting.

These variety groupings are quite distinct. As far as chlorosis is concerned, the first group, the one which shows definite resistance to chlorosis, should do well on all but the most alka-
line soils wherever grapes can be grown. The second group, which ranges from light to medium chlorosis, will not show such wide adaptation. However, these varieties should be able to produce fruit on many of the less-alkaline soils in Colorado. In this group are some of the better-known and more commonly grown varieties of American grapes.

The third group is made up of varieties definitely not adapted to average Colorado soils. It includes the common early blue variety, Moore's Early, and the white variety, Diamond. The varieties in this group cannot be recommended for planting in Colorado.

**Planting Distances**

With varieties of average size and vigor, grape rows should be from 8 to 10 feet apart and the plants should be 8 to 10 feet apart in the rows. Closer spacing of plants seldom will produce as heavy yields or as high-quality fruit as will the spacing suggested.

**Planting**

Before setting, grape vines should be kept moist and cool. All bruised or broken roots should be cut off and all roots cut back to 10 or 12 inches in length. All top growth except the two lower buds on the best cane should be removed.

The holes in which the plants are to be set should be of sufficient size to accommodate the plants without bending any of the roots and deep enough to set the plant at the same depth it was before. In most parts of Colorado, spring planting is preferable to fall planting.

**Pollination and Fruit Setting**

Most varieties of grapes are self-fruitful and will produce fruit with their own pollen, but there are a few varieties that cannot pollinate their own flowers. This fact is usually mentioned in catalog descriptions of these varieties and attention is called to the need of interplanting with perfect-flowered varieties. Whether a variety is self-fruitful or not can be determined by inspection of the flowers. The stamens of practically all self-fruitful grapes are upright and as long or longer than the pistil, while self-unfruitful varieties have short, reflexed, or deformed stamens.
PRUNING AND TRAINING GRAPES

The grape is one fruit plant which requires heavy pruning. The reasons back of this need are definite. Unpruned vines tend to overbear and produce small, inferior clusters or fruit. The amount of fruit produced can be reduced to the capacity of the vine easily and quickly by heavy pruning properly done. At the same time the amount of new growth made will be kept within desirable bounds.

Time to Prune

Grapes can be pruned at any time between leaf-fall and early spring, although the vines should not be handled when in a frozen condition. Late winter or early spring probably is the best time to prune in most parts of Colorado since winter-injured wood can then be removed and only living canes left. Pruning should be completed before the buds start to grow in the spring so that they will not be broken off. Late-pruned vines may “bleed” considerably, but this apparently does not cause serious damage. However, pruning is easier and more pleasant if done before the sap starts to flow.

Pruning Young, Non-Bearing Vines

After each of the first and second seasons’ growth, grape vines should be pruned so as to leave only two or three buds. By pruning in this manner greater root growth is induced and future production is better assured than when the vines are pruned less severely. However, if strong second-season growth is made, there is no objection to leaving several more buds at this time. After the third season’s growth, the method of pruning will depend on the type of trellis to be used.

Pruning Mature Vines

The number of buds that should be left on a grape vine after pruning will be determined to a large extent by the vigor of the plant and the fertility of the soil. A vigorous variety such as Brighton or Agawam can support from 40 to 60 buds, while a weak grower such as Delaware will do better with as few as 20 or 25. The grape vine will produce canes of different diameters. The most fruitful canes are those of moderate vigor, about the diameter of a pencil. Length between nodes should be in the medium range, or between 5 and 8 inches. All buds left after pruning should be on wood of this type.

A bearing grape vine may be compared to a pipe full of water under pressure. One or a few holes in a pipe will send out
long and forceful streams, but if there are many holes shorter or less forceful streams will result. Growth of new shoots on a vine react in a similar manner. If too few buds are left at pruning time, the shoots coming from these buds in the spring will be too vigorous. If too many buds are left, the shoots will not be vigorous enough. The lead-pencil-sized wood previously mentioned, which is saved for fruiting, comes from buds producing shoots of medium vigor. These moderate-sized canes are the most fruitful wood on the vine.

Thus it is seen that the vigor of each individual vine is the determining factor in the selection of the wood to save for fruit production. If growth is too vigorous in a season, a few more buds should be saved when pruning for the next season. If growth lacked vigor, fewer buds should be left.

Training Systems for Grapes

A number of systems of training have been developed for American grapes but only the two that are used in Colorado will be discussed here. These are the single-stem 4-cane Kniffin system and a modification of the fan system adapted to sections where winter covering of the vines is necessary.

SINGLE-STEM 4-CANE KNIFFIN SYSTEM.—This is the most common system of grape training and is adapted to the commercial areas in the 11 counties listed on page 3.

After pruning, a mature vine trained to this system will have a single trunk about 5 feet high (fig. 1) with four canes, two on each side, tied to a wire trellis. This trellis has the lower wire $2 \frac{1}{2}$ to 3 feet above the ground and the other 2 feet higher and directly above the first. These wires are supported by posts spaced from 15 to 18 feet or more apart. The wire used is usually size No. 9 or No. 10. For a plant carrying a total of 40 buds, each upper cane will have about 12 buds and each lower one about 8 buds. On a smaller or younger plant the numbers left on each cane should be reduced.

After these canes have fruited once, they are removed and new canes are selected to replace them. Four pencil-sized canes arising as near the trunk as possible are chosen. These canes also should be as near as is convenient to the wires to which they are to be tied (fig 1). Other growth is cut away except for short two-bud spurs left near each of the fruiting canes to provide new fruiting wood for the following year.
As the vines age, the fruiting wood tends to get farther and farther from the trunks, and the trunks themselves are sometimes injured or winterkilled. It is necessary, therefore, to watch constantly for strong new growths which can be used as replacements for damaged trunks, and for cane replacements at the bases of the fruiting canes. A vigorous new fruiting cane coming directly from the trunk is better than one coming from the end of a spur which has been formed by always selecting a new fruiting cane which has arisen from the old one.

Where a wire trellis is used, the wires should be tightened each spring, and the fruiting canes and the trunks should be tied firmly to them before new growth starts. In the Kniffin systems, which are most used with vigorous-growing varieties, the new shoots are allowed to droop, and only the older wood is tied to the trellis. For weaker growing varieties such as Delaware it is desirable to keep the new shoots upright by tying them to the upper wire of the trellis.

**MODIFIED FAN SYSTEM.**—A method of training used where winter-killing is an important factor is a modification of the fan system. Nearly all grape varieties are likely to winterkill in any but the most favored localities in Colorado. To grow grapes else­where in the State other than in the counties previously mentioned, and even at higher elevations in these counties, the vines should be laid down on the ground and covered with soil to protect them during the winter. Trunks should be renewed often;
in fact, it is often desirable to keep several trunks per vine to reduce the loss of plants by breakage in burying or raising them. Any covering used on grapes should be removed before growth starts in the spring.

In the modified fan system of training three to five canes of desirable size coming from or near the ground are selected each year and are cut back in the fall to leave the total number of buds desired for the plant according to its age and condition (fig. 2). All other growth is cut away. These three to five canes, then, are all that is left to cover since no trunks, or only short, temporary trunks, are ever allowed to develop. However, since there is always the possibility of cane breakage, it is desirable to leave one more cane on the plant to care for any emergency. This extra cane should be removed in the spring at the time the plant is uncovered. Pruning should be delayed as late as possible in the fall, since the first hard freeze will kill and shrivel the poorly-matured wood, making it possible to select only sound wood.

Instead of a permanent wire trellis, growers using this or similar systems use a 3- or 4-foot square frame with 2- or 3-foot legs at the corners (fig. 2). The vines are trained over the frame to keep most of the fruit off the ground. Such scaffolds, however, can support only the fruit borne on the buds on the middle of the canes, and both the lower buds and those hanging over the support will have their fruit on or near the ground. In the fall this frame is removed and the plants dropped to the ground.

Figure 2.—A mature vine would have longer and larger canes, or greater numbers than shown here. Being portable, this trellis facilitates covering.
**TILLAGE**

Cultivation is often recommended when grapes seem to need water. The number of times to cultivate and the tools to use depend largely on the soil and season, but ample cultivation of grapes is well rewarded. A common vineyard practice is to plow as early as possible in the spring and to follow this with a spring-tooth or disk harrow or a shovel cultivator thereafter.

Grapes root deeply. The soil can be worked from 3 to 5 inches deep in the space between the rows, but cultivation should be shallower close to the vines. Some growers throw a “ridge” to the vine in the fall and work it away the following spring. In seasons when the crop is large, cultivation should be continued later in the season than when the crop is small. The use of annual applications of 10 to 30 tons of manure per acre will be well repaid, not only in vigor of the vines, but also in improvement in the physical condition of the soil which will make cultivation less laborious and more effective.

**Cover Crop**

In years where a small crop is in prospect or where soil fertility and soil moisture will permit, it may be desirable to sow a cover crop early in August. At any rate cultivation and irrigation should be discontinued about this time to prevent late growth which seldom matures properly. Growing a cover crop such as rye or hair vetch not only improves the soil but also tends to check late growth and to hasten maturity of the vines. However, a cover crop planted in seasons of good yields competes with the ripening fruit and is likely to decrease fruit quality. Clean cultivation year after year without the addition of fertilizer or organic matter will soon impoverish the soil. On the other hand, well-kept vineyards are never allowed to remain in sod for any length of time. Where cover crops are used, they should be plowed under in the spring or early summer following the year they were planted.

**Late Irrigation**

Wherever irrigation is practiced, a late application of water, after the leaves have started to drop, is desirable to provide an ample supply of winter moisture.

**HARVESTING**

Grapes are full-sized and well-colored some time before they become fully mature. The sugar content of the fruit increases while it hangs on the vine but not after it has been picked. The
proper time to start harvesting is determined by a number of factors: By the use to which the fruit will be put; by the taste, color, and aroma; by the changing of the stem color from green to brown; and by the ease with which the berries separate from the stems.

Grapes to be used for jelly should be picked relatively early, since grapes that are too mature produce jelly that is dark in color and that may crystallize. However, the fruit should not be picked so early as to reduce yields substantially. Grapes for table use should be ripe. They are usually picked before fruit to be used for juice, which should not be picked until it is dead ripe.

Grapes should be cut from the vine with a knife or scissors. They never should be pulled from the vine. The clusters should be handled as little as possible, and they should never be handled when wet.

Packages used depend largely on market demands. The most common packages used in Colorado are Climax baskets of 2-, 4-, and 12-quart capacity, although grapes for jelly and juice are often handled in half-bushel and bushel baskets.

GRAPE INSECTS

Insects have not been so injurious to grapes in Colorado as in some of the intensive grape-growing regions. The following are those that have been most injurious:

GRAPE LEAF HOPPER, *Erythroneura comes* (SAY)

At the point of each puncture made on the under side of the leaves by this small sucking insect, a small whitish spot appears. If these feeding injuries become numerous the leaves take on a pale sickly color and under conditions of heavy infestation may wither and drop prematurely. Not only is the vigor of the plant and the size and quality of the crop reduced, but the small specks of excrement on the fruit are very objectionable. The adult leaf hoppers are about $\frac{1}{8}$ inch in length and pale yellow in color with red markings on the wings. They winter as adults under leaves, grass, and rubbish about the vineyard. The very small eggs are pushed into the tissue of the leaves. These hatch into the small and very active gray or whitish-green nymphs. There are usually two generations each season.

*By George M. List, Entomology Section, Colorado Agricultural Experiment Station.*
A spray consisting of ¼ pint of nicotine sulfate and 1 pound of fish oil spray soap or good laundry soap to 25 gallons of water is effective in destroying the small nymphs if thoroughly applied to the underside of the leaves. Spraying should be begun as soon as the young become numerous. In most parts of the State this is during the first part of June. Rotenone and pyrethrum dusts have been found effective.

Destruction of the rubbish and grass in the vineyard aids in reducing the numbers of adults that overwinter. This leaf hopper breeds in large numbers on the woodbine, and this plant should therefore be destroyed in the vicinity of grape plantings.

GRAPE BERRY MOTH, *Polychrosis viteana* Clemens

This small gray moth is seldom seen in the vineyard, but gives rise to two generations of larvae that may do serious damage. The first generation of larvae appears as the blossoms fall and can be detected by the presence of webs over the bunches of small grapes. They feed largely on the small fruits, making thin clusters or often destroying the entire cluster. The second generation of larvae appears when the berries are from one-half to two-thirds grown. These larvae eat into the berries where they feed on the pulp and seeds. The second generation of larvae overwinters in folds made in the grape leaves. Each larva makes a semicircular cut and folds back the part detached, thus forming a shelter for the cocoon.

Destruction of infested leaves is important in control. Spraying with arsenate of lead, 1 pound to 25 gallons of water, is the most generally used control. Usually two applications are sufficient, one shortly after the fruit has set and the other 10 days later. Under conditions of heavy infestation a third application when the berries are about half grown may be advisable to protect against the second-generation larvae.

GRAPE CANE BORER, *Schistoceros hamatus* Fabr.

The injury from this insect consists of burrows in the canes that usually start at a crotch or bud axil and follow the pith from 1 to 4 inches. The canes thus attacked usually break and die. These furrows may be made by the larvae or the adults.

The adult is a dark brown cylindrical beetle, about $\frac{1}{3}$ inch long. Eggs are laid on the canes of the grape and on the twigs of the apple and a number of other plants, the larva eating into the cane or twig. The injury from the larva is seldom noticed on the grape during the growing season, but in the spring the adult,
which has wintered in the larval furrow, moves about and furrows into the pith of other canes. The buds on such canes fail to develop. A very few beetles may destroy a large percentage of the canes after pruning has been completed. The only known control is the careful pruning out and burning of all infested canes.

**EIGHT-SPOTTED FORESTER, *Alypia octomaculata* Fabr.**

Grape vines growing in city gardens are especially likely to have foliage damage from the feeding of the caterpillars of this moth. The adult is an attractive velvety black moth with two pale yellow spots on the front wings and two white ones on the hind wings. The wing expanse is about 1 1/4 inches. The insects are day fliers and are often seen hovering over flowers. The larvae when full grown are about 1 1/3 inches long, and their dark bodies are gaudily marked with bands of orange, yellow, and black. There is a rounded hump near the hind end of the body. Individual vines can be protected against defoliation by hand picking the insects. Arsenate of lead as recommended for the grape berry moth makes an effective spray.

**GRAPE DISEASES***

Only a few grape diseases have been observed in Colorado. Of these troubles chlorosis, powdery mildew, crown gall, and damage due to winter injury are considered the most important. Since chlorosis has been discussed in some detail elsewhere in this bulletin (pages 4 and 5), consideration will be given only to the other diseases mentioned.

**POWDERY MILDEW**

The powdery mildew disease is caused by a fungus, *Uncinula necator*. It is common on most grape varieties, although as a rule it causes but little damage. The disease is characterized by the appearance of white to greenish powdery patches on the surfaces of green fruits, leaves, flowers, and canes. Frequently young shoots are attacked and may become dwarfed and malformed as a result. Later, usually in the autumn, small black pimple-shaped bodies appear. These are the overwintering structures of the mildew fungus. European grape varieties are more susceptible to attack by the mildew fungus than are American varieties.

Mildew occurs most frequently on vines which are shaded

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*By W. A. Kreutzer, Botany and Plant Pathology Section, Colorado Agricultural Experiment Station.*
to excess. Vines exposed to the sun and drying action of the wind seldom show serious mildew. Where mildew causes trouble annually, it is recommended that dusting sulphur be applied several times during the growing season.

CROWN GALL

Crown gall, crown knot, or root tumor, as it is variously called, is a disease of minor importance in the State. It is caused by bacteria (*Phytophthora* *tumefaciens*). The disease is characterized by gall-like tumorous growths on the roots, crowns of the stems, or even higher up on the canes. Crown gall will greatly weaken a plant.

To control crown gall, all nursery stock should be examined carefully and all gall infected roots discarded. Grape varieties resistant to crown gall are Concord, Catawba, Delaware, and a number of other American varieties.
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