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Growing Grapes
In Arizona

Cooperative Extension Service
And
Agricultural Experiment Station

THE UNIVERSITY OF ARIZONA

Bulletin A-33
The cover color photo of Cardinal grapes was taken by George C. Sharples in Maricopa county.

Trades names used in this publication are for identification only and do not imply endorsement of products named or criticism of similar products not mentioned.


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Growing Grapes
In Arizona

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THE GRAPE is one of the most useful fruits that can be grown commercially or cultivated in home gardens. The growing of table grapes is an important industry in Maricopa and Yuma counties.

In home gardens, grapes thrive over a wide range of soil and growing conditions in Arizona. The vines are ornamental and are often trained on an arbor for a shady retreat during the hot summer days.

The commercial grape varieties grown in Arizona are commonly known as the “European” grapes. They are derived from a native Western-Asia wild species—Vitis Vinifera.

These grapes produce well in southern Arizona. The Vinifera grapes need long, warm, dry summers and cool winters for best development.

At elevations above 4500 feet, the “American” grapes (slip skin) are grown. These are derived from native American wild vines or crosses with other species. The American grapes thrive best where there are fairly short, humid summers and cold winters.

There is no one “best” grape for either commercial or home plantings. Use the varieties best adapted to your area, and those that have the desired qualities for home or commercial trade.

### Varieties Adapted to Arizona

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#### 1. European Grapes

There are great differences in fruit production on vines of well adapted varieties and those not suited to Arizona conditions. For the home vineyard, it is best to select several high-yielding varieties whose ripening period spreads are over a considerable length of time. Also, include some which have different uses, such as for jelly or
eating out of hand. Different flavors and color will give variety in eating.

THOMPSON SEEDLESS

ORIGIN: PERSIA

Thompson Seedless vines are vigorous, very productive, and develop large, long, cylindrical, heavily shouldered clusters. The grapes are greenish white to light golden in color; always seedless; firm and tender in texture; neutral in flavor; and very sweet when fully ripe.

This variety ripens early in the season. It is adapted for commercial and home plantings.

Zones 1 and lower 2.

CARDINAL

ORIGIN: USDA — FRESNO, CALIFORNIA

The Cardinal variety resulted from a cross of Flame Tokay x Ribier and was first introduced in 1946. The most outstanding characteristic of this variety is the early date of ripening. It ripens about two weeks earlier than the Thompson Seedless in Maricopa County.

The vigorous, productive vines have dark green foliage with leaves of medium size. The fruit color is rich, dark red, with grayish bloom. Although the berries vary in size, they are large and have a slight muscat flavor, especially noticeable when fully mature.

The flavor is much better when berries are fully ripened. The seeds are rather soft, usually two per berry, but ranging from one to four.

Cardinal grapes are adapted for commercial and home plantings.

Zone 1.

EXOTIC

ORIGIN: USDA — FRESNO, CALIFORNIA

The Exotic variety also resulted from a cross of Flame Tokay and Ribier and was first introduced commercially in November 1958.

The first clusters are large, long, and with medium shoulders. The berries are blue in color, firm, medium large, being similar to Ribier. The texture is crisp, seed medium size and about three per berry.

Exotic ripens about 7 to 10 days later than Cardinal. The vines are very vigorous.

Zone 1.

PERLETTE

ORIGIN: UNIVERSITY OF CALIFORNIA

The Perlette variety was introduced as a hybrid by the University of California Experiment Station, Davis, California, in 1940. Vines develop slowly in early periods and increase in growth rate as the vines mature.

New unfolding leaves are bronzed and shoots light, bright green in color. Leaves are dark green without luster when mature; thicker and more leathery than Thompson leaves.

Fruit clusters are very compact. Berries are pale green to amber. Fruit ripens a week ahead of Thompson Seedless.

Perlette is adapted for commercial and home plantings.

Zone 1.

BLACK MONUKKA

ORIGIN: INDIA

The vines are very vigorous and productive. Clusters are large, very long, irregular to cylindrical. Ber-
BERRIES are reddish black to black, below medium size, and cylindrical. The skin is thin.

The berries are not high in sugar. They have neutral, but pleasing flavor. These grapes are seedless and early; a fine variety for home use. Black Monukka is well adapted to warm and desert regions, for home planting only.

Zones 1 and lower 2.

BEAUTY SEEDLESS

ORIGIN: UNIVERSITY OF CALIFORNIA

The Beauty Seedless was first fruited in 1946 and was the first black seedless grape produced by breeding. The clusters are long and compact. The berries are blue-black in color, firm, and sweet. Size is about that of Thompson Seedless.

This grape matures early and produces a heavy crop.

Zone 1.

PIERCE

ORIGIN: SAN JOSE, CALIFORNIA

The Pierce grape has carried many names, such as the Isabella Regia, Royal Isabella, California Concord, Western Concord, etc. It is a bud sport of the Isabella grape found by J. P. Pierce, of Santa Clara Valley in 1882.

The vines are very vigorous with large, thick leaves, producing many clusters of medium size, with large berries of a Labrusca type. The berries vary from purplish black to black with a light blue bloom.

The pulp slips from the skin as with all Concord or Labrusca type grapes. The flavor is similar to Concord, but does not rate quite as high as Concord.

Pierce is an excellent grape for home use and may be used as a table grape, or for unfermented grape juice. It ripens two or three weeks later than the Thompson Seedless. It is for home planting only.

Zone 1.

GOLDEN MUSCAT

ORIGIN: GENEVA, NEW YORK

Golden Muscat was introduced by the New York Agriculture Experiment Station in 1927. It is a cross of the Muscat of Hamburg and Diamond. The vines are vigorous with large leaves which tend to sunburn in western regions unless shade is provided. The berries are unusually large for an American type grape.

The skin slips from the pulp, and the flavor more nearly resembles the Labruska than the Vinifera Muscat. The outstanding feature of this grape for home use is the muscat flavor. Fruit ripens in late July and August; later in northern Arizona.

For home planting only.

Zones 1 and 2.

MUSCAT HAMBURG

ORIGIN: UNKNOWN

The Muscat Hamburg is medium in vine vigor. The clusters vary from loose to fairly well developed. The leaves are medium in size and dark in color. The berries are below medium size compared to other Vinifera table grapes.

Its delicate muscat flavor and aroma have given the Muscat Hamburg a place in home gardens. For home planting only.

Zone 1.
II. American Grapes

CONCORD

ORIGIN: MASSACHUSETTS

The Concord is the most popular and the most widely planted American type grape. The vines are vigorous and adapted to a wide range of soils and conditions.

The berries are black with a heavy blue bloom. Skin is rather thick and tough. Flavor is "foxy" and very aromatic.

The Concord is excellent for table use, juice, or jelly. It ripens in late August or early September.

Concord is good for commercial or home plantings.

Zones 2 and lower 3.

CACO

ORIGIN: NEW JERSEY

The Caco grape vines are vigorous and hardy, but only medium in productiveness. The clusters are tight and medium in size. Berries are light red, fairly large, with thin skins.

Caco is medium in sweetness and acidity. It is aromatic, and has a good dessert quality.

Caco is a home or local market grape and ripens a week before Concord.

Zone 2.

CATAWBA

ORIGIN: UNCERTAIN

Vines of Catawba are vigorous, hardy, and productive. Clusters are fairly large. They vary in shape and are rather loose.

Berries are purplish red, with a lilac bloom. Skin is thick and tough.

Sugar content is high, with a medium acidity.

Catawba has good flavor and eating quality. It ripens one to two weeks later than Concord.

Catawba is a home or local market grape.

Zones 2 and 3.

NIAGARA

ORIGIN: NEW YORK

Vines of the Niagara grape are vigorous, hardy, and productive. Berries are amber colored with a thin gray bloom. Skin is thin and tender. Niagara is sweet, juicy, and has a "foxy" flavor. It ripens about midseason.

Niagara is a good home garden grape.

Zones 2 and lower 3.

FREDONIA

ORIGIN: NEW YORK

The Fredonia has strong growing vines. It ripens early in the season. Clusters are medium in size and fairly compact.

Berries are black with a blue bloom; rather large in size. Skins are thick with tender flesh.

The flavor is "foxy" and aromatic. The fruit hangs well on the vine.

Fredonia is a good home garden grape and is also a good shipper. It ripens two weeks ahead of Concord.

Zones 2 and lower 3.

WORDEN

ORIGIN: NEW YORK

Vines of Worden are vigorous, hardy, and strong growing. Clusters are medium to large, with good shape.
Berries are large, black, and with heavy blue bloom. Skins are rather tender and tend to crack. The flesh is tough and juicy; flavor somewhat “foxy.”

Dessert quality is good. This grape ripens about the same season as Concord.

Zones 2 and lower 3.

**Propagation**

Grape vines may be propagated from seed, cuttings, layering, or by grafting.

Grape vines are generally grown from cuttings. During the dormant pruning season, cuttings should be selected from the pruning wood. Cuttings should be 12 to 18 inches in length, $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter and contain 4 to 5 buds per cutting.

The lower cut is made immediately below the lower bud, and the top cut, slanted at an angle, an inch or so above the top bud. This identifies the top and bottom of the cutting.

The cuttings are tied together in bundles of 25 to 50 cuttings per bundle, keeping the bottom of the cuttings even and together in the bundle. The bundles are then heeled in, or buried in a trench or pit, butt end of cuttings up, and covered completely with sand. (See photo.) The sand should cover the butt of the cutting bundles to a depth of about 3 inches.

Inverting the bundles causes the cutting to callus over on the butt end, while the top portion of the cutting will remain dormant. Cuttings which have been properly
callused will develop rootlets as soon as planted.
Callusing occurs in 30 to 40 days, depending on temperature. The sand in the callus pit should be kept moist, but not soaking wet, throughout the callusing period.
Many growers plant the cuttings directly in the field when soil temperatures reach 60° F. Cuttings may be stored under refrigeration at 35° F. until they are ready for planting.
A rooting is a one-year-old plant which has grown one year in a nursery row and is ready for transplanting in the vineyard. In salty soils where plants will not root readily from cuttings, one-year-old rootings offer many advantages in starting a vineyard.
Grapes also may be budded or green grafted if a rootstock is required for a special situation. In nematode or Phylloxera infested soils, resistant rootstocks are used to produce healthy vines. Greengrafting or budding is generally used to propagate varieties on resistant rootstocks. All rootstocks should be indexed or tested for freedom from virus diseases.
To start the vineyard with rootings, cuttings are grown in the nursery row for one year before transplanting to their permanent

"Layering" can be used to establish a missing vine.
A cane from a sister vine is brought to the ground at the location of the new plant and covered with soil. The cane remains attached to the parent vine until the new cane establishes roots and top growth.
The cane is cut away from the parent plant the following winter and trained to the stake to form the new vine.
location. The cuttings are planted on one side of the furrow, care being taken to place the slant end of the cutting up.

The top two buds of the cutting should be exposed above ground level. Firm the soil thoroughly around the cutting to prevent it from drying out. The cuttings should be placed 4 to 6 inches apart in the nursery row.

If one-year-old nursery stock is used in place of cuttings, each should be pruned to a single cane containing two buds when planted in the permanent location. Time of planting and planting procedure would be the same as for cuttings.

In the Salt River Valley, cuttings are generally used for propagation. On the Yuma Mesa most of the varieties are budded on the 1613 rootstock.

Layering is a method used to re-establish a missing vine in the vineyard. A cane from an adjacent vine is trailed on the ground to the desired location of the new plant and covered with two or three shovels of soil. The cane is allowed to remain attached to the parent vine until an independent root system is established at the point covered with soil. (See photo, page 7.)

In the spring or early summer of the following year, the cane is cut away from the parent vine and the new shoot trained up the stake to establish the new trunk system.

Spacing

The normal spacing for older grape plantings in commercial vineyards is 12 feet between rows and 8 feet between plants in the row. However, in newer plantings, a 12 x 7 spacing is being used (518 plants per acre).

In commercial vineyards adequate space must be provided for roads at the ends and sides of the vineyard, as well as driveways through the center of the planting, to give ready access for harvesting and cultural operations. Twenty to twenty-five feet will be adequate width for these driveways in most vineyards.

A minimum of one roadway should be made through each quarter mile. Many new vineyards have been planted with two roadways to facilitate picking where fruit is field packed.

It is very important to level any proposed planting site for grapes. If land can be leveled to form 1/10 to 2/10 grade before planting, a good job of irrigating can be done with a 660-foot run. Where grades will exceed this, it is advisable to shorten the runs. “Benching” or dividing field into two or more levels may be necessary where fall is excessive.

Grape plants may be established on any spacing in home plantings, provided there is adequate room to prune and thin the grapes and to control insects and disease with sprays and dusts. A 3- to 6-foot spacing is satisfactory when planting grapes for shade on an arbor or carport.
Selection of Suitable Sites, Planting, and Soil Types

The primary climatic factor influencing the growth and ripening characteristics of the grape is temperature. Table grapes in Central Arizona are economically successful because of high temperatures early in the season. The fruit ripens at a time when competition from other table grape areas is at a minimum.

Grapes should be planted in fertile, well drained soils. Grape vines produce earlier fruit and better growth on light open soils than on heavy clay type soils.

Highly alkaline soils should be avoided. A program of gypsum or sulfur applications may be needed to maintain good chemical balance. Check with the local County Extension Agent.

A complete water analysis including boron and lithium should be run on irrigation wells on proposed grape planting sites. Good water for grapes should contain less than 700 p.p.m. of total soluble salts. Boron content should not exceed 0.5 p.p.m.

The rows generally should run east and west for better shading effect on the fruit. The vineyard should be carefully laid out for ease of culture, harvesting, and other operations.

Vine locations should be marked before planting begins. Row and

Place callused cutting at the side of the stake.

Fill the hole and firm the soil around the cutting, leaving at least one bud above ground level.
cross marking may be done with tractor mounted markers, wires marked at correct distances or staking. Some growers are placing pre-assembled stakes and crossarms in the row at the time of planting.

If cuttings are used to establish the grape planting, they should be set in the field in mid-March or early April, or when the soil temperature reaches a minimum of 60°F, and planted in the selected location. Plant about 10 percent extra cuttings in a nursery row to use as rooted plants to replace those that fail to grow the first year.

Cuttings are placed in the row at pre-marked spacings. The newly planted cuttings should be irrigated immediately.

**Training the Vines**

This is one of the most important phases in establishing grape vines. If vines are properly trained they can be easily pruned and cared for with a minimum of effort. Cuttings planted in a permanent location are allowed to grow unhampered for the first season; then one cane is pruned back to a two-bud spur, and all other canes are removed from the plant.

When a cutting has grown one year and has been pruned to two buds, or the rooted plant pruned to two buds, it is ready to be trained on the stake. (See Photos.)

If staking has not been done at planting time, a permanent trellis with a stake near the plant should be erected in the winter or early spring of the second season to facilitate training the new grape vine. The first straight shoot which develops on the plant should be tied loosely to the stake.

**Tie Shoots**

As the shoot develops, it is tied securely at 2 or 3 levels. When terminal has grown to a height of 6 to 7 feet it is headed back 40 to 50 inches above ground level, depending on height of trellis, to promote lateral shoot development. The current trends are to use 7- to 8-foot stakes, thus necessitating the raising of the head to 40 or 50 inches.
Training during the second season. Left: As shoot starts, disbud and train to stake. Center: Use two or more ties — keep straight. Right: In 6 to 8 weeks, when vine has grown above the wire or stake, pinch off or cut the tip just above the wire.

Train at least two laterals on the wire as fruiting canes or cordon for the next season.

Vine at the end of the second season before training to vine system of pruning.
The leaves should not be removed, for they provide shade for the tender shoot during the first year of development of the tender trunk. However laterals should be removed.

The shoot which develops from the second bud is allowed to grow for a portion of the first growing season. This shoot provides a second or insurance cane for training into the permanent trunk if for any reason the first shoot breaks or becomes severed from the plant. This shoot is removed later in the season after the trunk has been established.

During the first growing season from rooted vines, or the second growing season from cuttings, lateral shoots are trained on wires to provide canes or cordon arms for the next season.

Vine Parts

Definitions of vine parts are outlined below to give a clear picture of the plant structure:

**SHOOTS** are the current season's succulent top growth, arising from canes or cordons.

**CANES** are matured shoots of the previous season's growth.

**CORDONS** are horizontal extensions of the trunk which give rise to fruit-bearing shoots.

The **TRUNK** is the undivided main stem of the vine.

A **SPUR** is the basal portion of a cane which has been pruned to two or three nodes in length.

A **RENEWAL SPUR** produces shoots that are used the next season for fruiting canes.

A **SUCKER** or **WATERSPOUT** is a vigorous shoot that grows from the root, trunk, or crown of the plant, usually large diameter and long internodes.

A **FRUIT CANE** is a basal section of a cane which produces the next grape crop.
Pruning

The vines are pruned to cut away canes which produced the grape crop last year and to reduce the present productive canes to the desired number of buds for the coming season.

Pruning consists of removing canes, shoots, leaves, and other vegetative parts of the vine. Summer pruning may be employed when it is necessary to remove one shoot where doubles occur.

The removal of one shoot will force all of the growth at that point into the remaining shoot. The practice should give more vigorous fruit canes for the next fruiting year.

Grape clusters are borne on shoots or canes which developed on last year's wood.

Grape vines should always be pruned when they are fully dormant. In the process of pruning the grower accomplishes three important things:

1) The size of the vine is maintained within the limits of economical production practices and convenience.

2) The size of the following season's crop is greatly reduced, simplifying the work of fruit thinning which is necessary to avoid overcropping.

3) The useless, 2-year-old wood which bore the past season's fruit crop is removed as well as dead and broken canes.

Many varieties of grapes which are produced commercially must be cordon pruned. In cordon type pruning all wood is removed except for 6 to 8 fruiting spurs on each cordon containing 2 or 3 buds each. (See above and page 14.)

The cordon-trained vine can best be described as having one or more lateral extensions from the trunk which are developed 30 to 40 or 40
An established vine pruned to a cordon with lateral fruiting spurs. (Note the four girdles on the main trunk.)

A Thompson Seedless vine pruned to the cane system, showing fruiting canes tied to wire.
to 50 inches above ground level. From these lateral extensions vertical spurs develop. (See photo at left.) The buds on these spurs produce the shoots on which fruit clusters are borne.

The Cardinal and Exotic varieties are normally cordon pruned; all others are normally pruned to canes.

Home grape plantings are pruned the same as commercial plantings.

In cane pruning, the trunk of the vine is trained the same as cordon except a "head" is formed at the first wire instead of cordons. In cane pruning, select four to six well placed fruiting canes (2 or 3 in each direction) which will bear fruit the coming season, and cut these back to the desired number of buds (8 to 15).

Then four to six canes are cut back to two buds. These are called renewal spurs and produce canes that will bear fruit the next season. (See photo bottom of page 14.)

**Thinning**

Thinning is the practice of reducing the total amount of fruit on the vines. It has been experimentally demonstrated that removal of some of the flowers or immature fruit clusters from the vines causes the remaining clusters to produce fruit which is either larger or earlier ripening or both.

Within limits, the amount of increase in size or earliness is more or less in proportion to the number of clusters removed. Presumably the removal of some of the fruit increases the supply of nutrients available for the development of the fruit which remains.

Four types of thinning are normally practiced: (1) flower cluster thinning; (2) flower cluster tipping; (3) fruit cluster thinning; and (4) berry thinning. Each type of thinning has a special purpose, however, and the choice of the proper one to use depends largely upon the variety being grown.

**FLOWER CLUSTER THINNING**

This method of thinning consists in removing the rudimentary flowers which appear with the new growth in early spring. The removal of immature flower clusters at this early stage of growth not only provides nutritional advantages to future growth of remaining clusters, but may also tend to increase the number of berries that set. For this reason, flower cluster thinning is useful for varieties that tend to have loose or straggly clusters.

**FLOWER CLUSTER TIPPING**

This method of thinning consists in removing before blossoming relatively small portions of the tips of the central axes of the immature flower clusters. With some varieties this practice may be more effective for improving berry set than removing entire flower clusters.

When an average of ¾ inch was removed from Cardinal flower tips just before blossoming, the yield of No. 1 grade fruit under controlled conditions was increased by more than 100 percent, while the total yield of fruit was reduced less than 20 percent. This practice is now widely used in Arizona to obtain Cardinal grape clusters of higher quality.
FRUIT CLUSTER THINNING

Fruit cluster thinning consists in removing entire clusters of immature berries soon after the blossoming cycle is complete and the berries have set. This is the most convenient and widely practiced method of thinning grapes. Since cluster thinning is performed after flowering, it does not influence the number of berries that set.

It is suggested that clusters be thinned to one per shoot. Size and earliness of most varieties are improved, however, and it makes possible a more critical selection of clusters for greater eye appeal. The poorer appearing ones may be discarded during the thinning operation.

For commercial purposes, mature vines of table grapes are usually thinned to 20 to 40 clusters, depending on variety, age of vines, and market conditions. Grape vines in home plantings may carry somewhat more than this, according to individual desires.

BERRY THINNING

Berry thinning consists in the removal of individual berries or portions of clusters. The use of this method is limited to varieties which set very large or very compact clusters. The quality of Thompson Seedless clusters, which are typically large and elongated, is improved by removing the lower portion of the cluster and some of the branched stems of the upper portions.

Clusters of Perlette, which are extremely compact, must be berry thinned so that the remaining berries can develop normally. For maximum effect this type of thinning should also be performed immediately after fruit is set.

Girdling

Grape vines are girdled for the following purposes: (1) to increase berry size, and (2) to hasten fruit maturity. The particular response desired determines the time at which girdling is to be done.

Girdling consists in removing a continuous ring of bark 3/16 inch to ¥4 inch wide from the trunk, arm or cane below the fruit which is intended to be affected. The removal of such a band of tissue, provided it is done correctly, interrupts the normal flow of sugar from the leaves where it is produced, to the roots where it is stored, without interruption of the flow of water and minerals from the root system.

The resulting increase in sugar concentration above the girdle greatly influences the development of the fruit. Girdles on vigorous vines which receive proper care usually heal over in 3 to 4 weeks.

The berry size of seedless varieties, such as Thompson Seedless, is greatly increased by girdling immediately after the period of normal berry shatter and before rapid fruit growth begins. In Arizona, girdling of seeded varieties to increase size is of doubtful value.

By girdling just before ripening begins, the time of maturity of many seeded varieties of grapes can be advanced by as much as 2 weeks, if other conditions are not limiting. For best results, Cardinal
These tools are used in the girdling operation. Left, pliers used for girdling canes. Right, (two views), double-bladed knife used in trunk girdling.

and Exotic varieties should be girdled when the first traces of color appear. The ripening rate of seedless varieties such as Thompson Seedless is affected little or none by girdling at this state of growth.

Vines less than 3 years old should not be trunk girdled. Two-year-old vines may be girdled if care is exercised.

Girdling is not particularly recommended for home grape plantings. Without the proper tools and a full understanding of the principles of plant structure and physiology involved, there is danger of fatal injury to the plant.

Growth Regulators

Berry size and yield of Thompson Seedless grapes are increased by spraying vines with gibberellins. Solutions of this material, sprayed on fruit clusters within a week following berry shatter at rates of 20 to 40 parts per million, will produce a berry size increase approximately equivalent to that resulting from girdling alone.

A combination of gibberellin treatment and girdling produces larger berries than either spraying or girdling alone.
Irrigation

The fundamentals of irrigation of grapes are fairly simple. However, the individual needs of grapevines grown in different soil types vary considerably. Available soil moisture must always be present in the root zone during the growing season, and during the period when the most rapid growth of the berries normally occurs.

Bearing vines develop very rapidly, resulting in a succulent type of growth in the spring and early summer. Normally a gradual slowing of shoot growth occurs as the berries enlarge. The rate of growth slows more and more and almost stops as the fruit begins to ripen. A moderate shortage of available water will greatly reduce the normal rate of growth of a grapevine. A further reduction in moisture supply may be detected by the appearance of a soft, yellowish-green color in the growing tip leaves. As the plant becomes stressed, this soft green color will turn to a grey-green color and growth of the plant will almost completely stop.

When large portions of the root zone have been depleted of readily available water, leaves begin to curl, and the older leaves desiccate and die.

Grapes grown in the Salt River Valley will require from 3 to 4 acre feet of irrigation water, depending on the soil type. In the lighter sandy soils grapes may require 5 to 6 acre feet of water to produce a satisfactory crop and to provide for normal vine growth.

The grape is a deep-rooted plant, so a heavy irrigation should be applied in the early spring just before growth starts to wet the soil to a depth of 6 to 8 feet. The young developing shoots, leaves, and fruit require little water in March and April. As the leaf area increases and the berries begin to enlarge, available water should be constantly maintained throughout the root system. Tensiometers are useful aids in determining water penetration.

Results have shown that a very heavy irrigation just before bud break is necessary to fill the subsoil with moisture. Bud break may vary from February 1st in Yuma to March 15th on heavy soils in the Salt River Valley.

It should be pointed out that much of the well water in grape growing areas of Arizona contains substantial amounts of nitrate nitrogen. Therefore care should be taken to prevent the use of more water than necessary for good vine growth, as such a practice may result in over-fertilization.

After the crop is harvested, the rate of vine growth should be reduced. To accomplish this, the schedule should be lengthened to intervals of one month or more. When the vines become semidormant they should be given an irrigation to carry them through the winter.

For areas with light sandy soil, it may be necessary to apply an additional irrigation during the late summer and fall months. Home gardeners should follow these same general principles in irrigating their vines.

Irrigation may be a factor in the problem of shattering of grape clusters during the blooming period. Shattering or shedding of the flowers usually occurs when the
vines have not been irrigated in the spring before the blossoms appear. The first irrigation in the spring should be applied prior to bud break. Shattering, or shedding of the cluster, is reduced to a minimum when planned irrigation schedules are followed.

**Fertilization**

In the Salt River Valley, grape vines respond chiefly to nitrogen applications. Test applications of phosphorus and potassium have not given visible response in grape vines. In the deep soils of the valleys and mesas the addition of nitrogen has not been required for a number of years to maintain vine vigor and produce satisfactory crops. On very sandy mesas 100 to 120 lbs. of N per acre may be needed per season for vine growth and fruit production. The annual growth is a very good index to the fertilizer needs of the plant. Too much nitrogen fertilizer results in extremely vegetative vines with light fruit set of poor quality. The only reliable method of determining fertilizer needs of grape vines is by petiole analysis. Petiole samples should be collected at full bloom for analyzing. Field tests should be conducted on several rows to determine fertilizer responses. Barnyard manure can be used to advantage in commercial and home plantings to maintain vigor and production in getting the vineyard established in sandy or rocky soils. Do not use over five tons of barnyard manure per acre annually.

**Cultivation and Weed Control**

Cultivation in the grape vineyard is done principally to control weeds, and to help incorporate cover crops and manures and make for better irrigation. The vine prunings are chopped and left in the vineyard for the fertilizer and organic benefit, saving labor of removal from the vineyard. Cultivation or disturbing the vine roots during the dormant season is not recommended. Deep cultivation is not recommended at any time. In young vineyards, French plowing is generally necessary to control weeds in the vine row. In mature vineyards where broadleaf weeds are not a problem, and grasses can be chemically controlled, the use of French plowing for weed control has decreased. French plowing may facilitate better leaching of salts from the vine row where they have accumulated during the previous growing season. The principal chemical weed killer being used in Arizona vineyards is DALAPON for control of Bermuda and Johnson grass. Dalapon should be used only around vines three years old and older. Limited use of pre-emergent broad-leaf weed killers such as DIURON and SIMAZIN has started
in the Salt River Valley. These materials are applied once a year, after pruning and before the first spring irrigation. Only the vine row is sprayed.

The directions of the manufacturer should be followed exactly when using any of these materials. The amount applied per acre depends on soil type, vines growing in light sandy soils again being most susceptible to damage.

Grape Diseases

By Ivan J. Shields, Agent-in-Charge, Maricopa County
And Arlen D. Davison, Extension Plant Pathologist

In general, diseases of grapes are a minor problem if some preventive measures are taken. In new plantings use certified or diseases-free wood. Several virus diseases can be spread through propagation wood.

If you are to take cuttings from your own vines, check parent vines for disease symptoms for at least two previous growing seasons before taking wood for propagation. Remove weak and low producing vines regularly. Make at least two disease inspections in the nursery row before transplanting the grape plants in the vineyard.

Grapes should be planted in soil free of Texas Root Rot, Bacterial Crown Gall, and Root-Knot Nematodes.

TEXAS ROOT ROT

Grapes that are attacked by Texas root rot will wilt suddenly. The leaves hang limp for a few days and then turn yellow and die. An examination of the roots will show a browning and rotting of the outer cortex. The disease is most active in July, August, and September.

An application of one pound of ammonium sulfate per ten square feet of soil around the base of infected grape vines recently affected by root rot may save the vine if applied soon enough. The ammonium sulfate should be flooded in and the vine growth pruned back to 50 percent.

The application of steer manure or other organic materials to the root-rot spots will help prevent the infection, although it is too slow acting to check the disease in plants already infected.

Wherever possible, do not plant grapes on land known to be infested with the Texas root rot fungus. If new land is to be planted, it can be checked for presence of the root rot organism by planting cotton or alfalfa for one year. If root rot is not observed in these crops, there is reasonable assurance that the organism is absent.

BACTERIAL CROWN GALL

A warty growth may occur on grape roots or vines near the soil surface. The above-ground infections appear as rough woody galls, one inch or so in diameter, or as a long series of galls extending a foot or more along the canes. The underground infections will form a gall about the size of a golf ball or larger.

The presence of crown gall will
weaken the vine and make it unproductive. These vines should be removed as crown gall can spread to other vines.

The production of clean planting stock is the most satisfactory approach to crown-gall control. Choosing a field free of the crown-gall bacteria, and control of chewing insects also are important.

The incidence of infection on new planting stock can be reduced by dipping the roots in an antibiotic solution, Agri-mycin 100 or Agristrep. Follow the label directions to prepare a 100 part per million (ppm) solution. Roots should be dipped thoroughly and planted without rinsing. This treatment kills bacteria on root surfaces and in incipient infections, preventing the development of the disease if the bacteria are not present in the soil.

This disease organism can also attack roses, pyracantha, fruit trees, and many other plants. It remains in Arizona soils for several years and usually infects plants through injured roots or bark.

**POWDERY MILDEW**

This fungus often becomes active on vinifera varieties as soon as spring growth starts, and may continue to some extent throughout the growing season. It is the period from spring to harvest that controls are most necessary.

**Symptoms**

The disease forms whitish spots on leaves, on canes, and on fruits—giving them the appearance of having been dusted with flour. These spots often enlarge and may cover the entire surface. The affected leaves are retarded in growth and of an odd shape.

The canes will soon exhibit rusty red spots, which become dark in the affected area. The mildewed fruit may split and fall, or in some cases, dry up in the cluster.

**Control**

Dust or spray applications should begin before symptoms appear. Sulfur will protect the vines from infections, but has little effect on established infections, except at high temperatures. If eradication is desired, apply sulfur as a spray.

Sulfur dusts give excellent protection against grape mildew, providing the material is applied thoroughly and at regular intervals. A suggested dusting schedule is as follows:

1. Apply first dusting when vine shoots are 6 to 8 inches long at the rate of 10 to 15 pounds per acre.
2. Apply a second dusting before blossoming, usually when vine shoots are 2 to 3 feet long, at the rate of 15 to 20 pounds per acre.
3. Apply a third dusting in late June or July when berries are one-half size. Use 25 pounds of dusting sulfur per acre by ground rig or 50 pounds by plane.

Heavy sulfuring during hot weather may cause a burn. During seasons when mildew is prevalent, a total of five dustings may be necessary.

In sulfur sprays, applications of five pounds of wettable sulfur and a suitable spreader to 100 gallons of water should be used. The first two applications will take about 100 gallons to the acre, but a third application may take 150 gallons per acre for adequate coverage. Sulfur is compatible with Malathion and DDT, and the two materials may be used together when necessary.
Evening applications just before an irrigation should lessen chances of burning later in the season and still give maximum control.

4. Post-harvest applications are rarely necessary. In severe cases where a noticeable amount of cane infection is evident a late August or September application may be applied.

ROOT KNOT

In sandy and sandy loam soils, nematode infestations often build up rapidly and soon reduce yields in grapes. In planting new vineyards, nematode-resistant rootstocks should be used in these soil types. In loam and clay loam soils, root knot is usually not a problem.

In established vineyards with moderate root-knot infestations, some increase in yield may be effected with more frequent irrigations.

In severe root-knot infestations, apply DBCP (Fumazone or Nema-gon) with a 4 to 5 inch irrigation. Tests indicate that 2½ gallons of Technical DBCP to the acre are sufficient for a good kill of the nematodes. It may be necessary to treat only the sandy portions of the vineyard. Special metering devices are necessary for good mixing and distribution of the fumigant.

Thus the leaves at the base of the canes are green and the farther out on the shoot the smaller and more chlorotic the leaves become. The tissue close to the vein is the greenest and the areas between the veins are whitish or yellowish green.

The yields may be reduced on vines that are only slightly affected and badly affected vines may produce very low yields.

The most economical way to supply needed zinc to the vine is to daub the pruning cuts with a zinc sulfate solution. One pound of zinc sulfate, dissolved in a gallon of water, should be applied to pruning cuts within two hours after pruning. (See photo below.)

The foliage can be sprayed with zinc materials for additional response. However, these foliage sprays should supplement the dormant season application.

Daub the pruning cuts with zinc sulfate.

LITTLE-LEAF
ZINC DEFICIENCY

Grape vines affected with little-leaf disease have stunted leaves. In zinc deficiency, the first leaf formed on the shoot is usually normal or only slightly yellow. The yellowing becomes more severe as the shoot develops.
PESTICIDE RESIDUES

These suggestions are based on the information currently available for each pesticide listed. If followed carefully they should result in satisfactory control and should not leave residues that will exceed the tolerance established for any particular chemical. To avoid excessive residues on crops, follow directions carefully with respect to dosage level and the minimum interval between applications and harvest.

READ THE LABEL.

Take Care

The grower is responsible for residues on his own crop as well as for problems caused by drifts from his property to other crops. Don't use new materials unless they are registered and tolerances have been established.

Grape Insects

By J. N. Roney, Extension Entomologist

Grape growers in Arizona, both the backyard and commercial producer, find very few insects attacking grape plantings.

LEAFHOPPERS

There are two leafhoppers: one called the grape leafhopper; the other, the variegated leafhopper.

The adult leafhoppers are about one-eighth of an inch in length, pale yellow, with red or black markings on the front wings. Both leafhoppers are about the same size. The eggs are laid in the leaves and hatch in about two weeks.

The pale wingless nymph (immature stage) feeds on the lower surface of the leaves, casting skins five times before becoming an adult. It takes about three to four weeks for the young to reach the adult stage.

The leafhopper injury on leaves appears in a speckling of the leaves, caused by the feeding of the leafhoppers with their small beaks. The leafhopper sucks out the plant juices and leaves a pale greenish-yellow spot that is easily noticed. Usually a closer observation will show the young leafhopper to be present. Some seasons the 'hoppers cause injury during the spring and again late in the fall.

Growers formerly used Pyrethrum sprays for control. Then DDT sprays were used. However, in some cases the 'hoppers became resistant to DDT.

Recent research has shown that best results may be secured with a 5 percent Malathion dust or a spray. Apply about one pound of technical Malathion per acre. This means about 1½ teaspoonsful of 50 percent Malathion emulsion concentrate per one gallon of water.

Malathion dust is used at the rate of 20 pounds per acre per application. Some growers still use DDT, but when this fails, they use Malathion.

You may use one pound of 50% W Diazinon in 100 gallons of water. Do not apply within 18 days of harvest.
Sevin has been used at the rate of \( \frac{1}{2} \) to 1 pound of technical material per 100 gallons of water. Sevin may be used up to and including the day of harvest on grapes.

**SKELETONIZER**

In the small backyard vineyards, the western grape-leaf skeletonizer gives about as much trouble as the leafhopper. In certain parts of the state it causes more damage than other grape insects.

The larva, or worm stage, of this insect is black and yellow (six-banded), and feeds only on the underside of the leaves.

A 50 percent Cryolite dust or a 5 percent Malathion dust will give good control of this insect. When applying an insecticide, be certain to get the material on that portion of the plant where the insect is feeding. Quite often poor controls are secured because of poor application.

Sevin has been used at the rate of \( \frac{1}{2} \) to one pound of technical material per 100 gallons of water. Sevin may be used up to and including the day of harvest on grapes.

**FLEABEETLES**

Fleabeetles are sometimes a problem. This small brown beetle may feed on the leaves, leaving small holes. Some species in the higher elevations are of a metallic blue or green color.

Fleabeetles may be controlled with a 5 percent Malathion dust or a spray of 1 to \( \frac{1}{2} \) teaspoons of a 50 percent emulsion concentrate in one gallon of water.

**DARKLING GROUND BEETLES**

This small beetle winters over at the base of the vine, under the bark. In Yuma, it has destroyed the buds when they first start to emerge.

Dusting with a 10 percent Chlor dane dust has given good results.

**SPHINX MOTH LARVA AND CABBAGE LOOPER**

Occasionally sphinx moth larvae and cabbage loopers feed on the foliage of grape plants. Usually a 10 percent DDT dust will give the desired control results.

Be careful in using insecticides.

**BE SURE TO READ THE LABELS!**
This publication is issued by the Cooperative Extension Service and the Agricultural Experiment Station of The University of Arizona. See your local County Extension Agent for additional information.