Pakistani

GRAPES

An SRD Technology Training Manual™

Adapted for use in Pakistan

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Grapes: Part I Production

David G. Himelrick

A. Vineyard Establishment 1
1. Vineyard Layout 1
a. Direction of the Rows 1
2. Planting the Vines 2
a. Purchase Healthy Vines 2
b. Heal-In to Prevent the Unplanted Vines from Drying Out 2
c. Trimming the Unplanted Vine 2
d. Handling the Vine 2
e. Digging the Hole 3
f. Planting the Vine 3
3. Trellis Construction 3
a. Trellising the First Year 3
b. Trellising the Second Year 3
4. Construction Procedure 3
a. End Posts 4
b. Bracing Methods 4
c. Intermediate Posts 5
d. Stakes 5
e. Wires 5
f. Connecting wires 6
g. Cordon Trellis 6
h. Cane Trellis 6
i. Table Grape Trellis Designs 6
j. Trellis Maintenance 6

B. Vine Training 6
1. Training Begins at Planting 8
2. Cordon Training 8
a. First Year 8
b. Second Year 8
c. Third Year 10
d. Fourth Year 11
3. Cane Training 11
a. First Year 11
b. Second Year 11
c. Third Year 12
d. Fourth Year 12

C. Pruning 12
1. Growth and Fruiting Habits 12
2. Time of Pruning 13
3. Pruning Principles 13
4. Cordon System 13
5. Cane System 14

D. Common Training Systems 14

E. Disposal of Prunings 14

F. Weed Control 15
1. Preplanting Weed Clean Up 15
2. Mechanical Weed Control 15
3. Chemical Weed Control 15
a. Preplanting Chemical Weed Control 15
b. Vineyard Chemical Weed Control 15
c. Herbicide Application 16

G. Irrigation 16
1. Establishment Irrigation 16
2. Mature Vine Irrigation 16
3. Salinity 16
4. Irrigation Methods 16
5. Drip Irrigation 17
a. Components and Equipment 17

H. Fertilization 18
1. Laboratory Analysis 18
2. Soil Analysis 19
3. Nitrogen Requirements 19
a. Excess Symptoms 19
b. Time of Application 19
4. Iron 19
a. Correction of Deficiency 20
5. Zinc 20
a. Deficiency Symptoms 20
b. Correction of Deficiency 20

I. Cluster Thinning 20
1. Thinning Versus Pruning 20

J. Propagation 21

K. Changing Varieties by T-Budding 21
1. Bud Sticks 22

2. Inserting the Buds 22
3. Wrapping the Bud 22
4. Care After Budding 23

L. Varieties 23

M. Rootstocks 24

N. Seedless Table Grape Production Practices 24
1. Girdling 24
a. Purpose of Girdling 25

O. Plant Growth Regulators 26
1. Ethephon 26
2. Gibberellin/Gibberellic Acid 26
a. Gibberellic Acid Spray Guidelines 26

P. Harvesting 29
1. Proper Picking Time 29
a. Sugar Test 29
b. Acid Titration 29
c. Degree Brix Acid Ratio 29
d. Estimating Maturation 30
2. Criteria of Quality 30
3. Packing 30
a. Field Packing 30
b. House Packing 31

Q. Thompson Seedless 31
1. Description 31
2. Training and Pruning 31
3. Flower Cluster Thinning 31
4. Gibberellic Acid Sprays 31
5. Girdling to Increase Berry Size 32
6. Cluster and Berry Thinning 32

R. Flame Seedless 32
1. Description 32

2. Training and Pruning 32
3. Shoot Thinning 32
4. Flower Cluster Thinning 32
5. Gibberellic Acid Sprays 32
6. Girdling to Increase Berry Size 32
7. Berry Thinning 33
8. Color Enhancement 33

S. Ruby Seedless 33
1. Description 33
2. Training and Pruning 33
3. Shoot Thinning 33
4. Berry Thinning 33
5. Fruit Exposure 33
6. Special Considerations 33
7. Ethephon 33

T. Perlette 34
1. Description 34
2. Training and Pruning 34
3. Shoot Thinning 34
4. Pre-Bloom Flower Thinning and Cluster Tipping 34
5. Gibberellin Sprays and Girdling 34

Grapes: Part II Harvesting and Handling

M. Joseph Ahrens Ph.D.

U. Structure 35

V. Development and Maturation 35

W. Factors Affecting Deterioration 36
1. Field Conditions 36
2. Temperature Effects 36
3. Mechanical Injury 37

X. Decay 37
1. Botrytis rot 37
2. Cladiosporium rot 37

3. Penicillium rot 37
4. Aspergillus and Rhizopus rots 37

Y. Field Handling 37
1. Harvesting 38
2. Transport from the Field 39

Z. Shed or House Packing 39
1. Receiving Fruit from the Field 39
2. Dumping/Grading/Packing 39

AA. Cooling 41

AB. Fumigation with Sulfur Dioxide 42

AC. Transport & Storage 42

AD. RECAP 43

Glossary of Terms 44

Supporting Literature 46

Grapes: Part I Production

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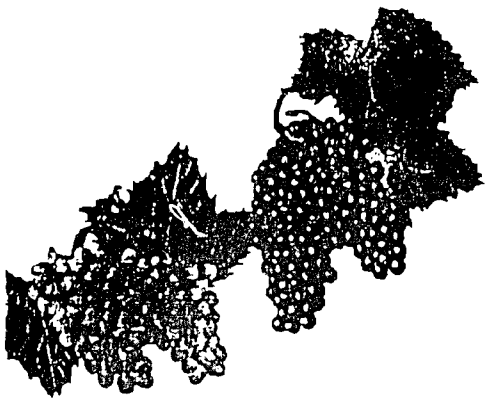
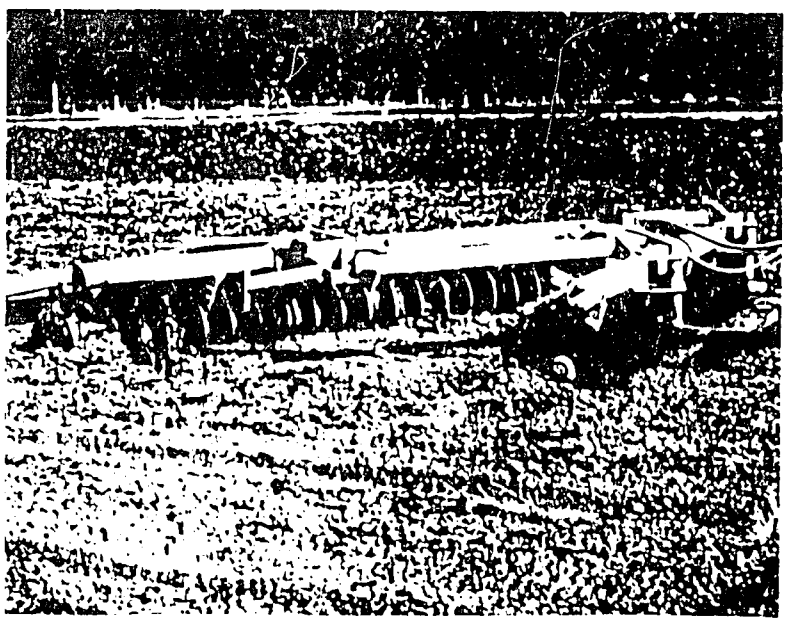
This manual contains occasional references to Texas grape production practices. These should be viewed simply as a typical representative cultural practice which should be directly adaptable to Pakistan. All material and other management suggestions should work well under Pakistan conditions.



A. Vineyard Establishment

Site preparation should begin well in advance of actual vine planting. Remove trees, brush and large rocks, and kill perennial weeds. Remove brush from the site so that it does not interfere with trellis construction, planting or vineyard management.

Use chisel plowing to break up plow pans and cut roots. This can be done with a tractor to a depth of 18 inches. At least two trips down the row are needed; four trips would be ideal. The soil should be relatively dry for the plow pan or clay layers to be broken.



Deep plowing is needed in the winter months or dry summer months to kill perennial weeds such as johnsongrass and bermudagrass.

Disking follows deep plowing to begin breaking up soil clods and smoothing out the vineyard row. For the disk to work properly, the soil cannot be wet or totally dry.

In tighter, poorly drained soils, use a bedding disk to build a low terrace down the row for improved surface water drainage away from the vines.

1. Vineyard Layout

When planting a vineyard remember that it will be set as you plant it for many years. Plan the design well on paper before the planting date.

a. Direction of the Rows. Row direction depends on a number of factors that should be evaluated for each vineyard site. Factors to consider include prevailing spring wind direction, maximum light interception, slope of the land and pesticide spray runs. As a general rule, rows oriented in a North-South direction give the best light exposure to leaf canopy of the vines.

Vine foliage protects the fruit from sunburn when rows are planted in a southwesterly direction. The sun strikes the top of the foliage during the hotter part of the day.

For hillsides, plant on contoured terraces to prevent surface erosion and to maintain uniform water pressure throughout the drip irrigation system.

In some areas of Pakistan, flood irrigation may be used. The slope of the land determines the direction to plant rows. Flood irrigation and straight rows are adapted to relatively flat lands that can be graded to slopes of 0.15 percent or less.

If a square or rectangular site is cleared on level ground, sides of the rectangle should run southwest and northeast, and the ends should be square and at right angles to the sides. On small acreages, it may not be possible to arrange a southwest to northeast rectangle because of property borders. In this case, plant rows running parallel to the border. Such an arrangement avoids leaving land unused and helps insure that vineyard rows are the same length.

It is important to have vineyard rows about the same length for easier management operations. Having rows the same length avoids undue damage

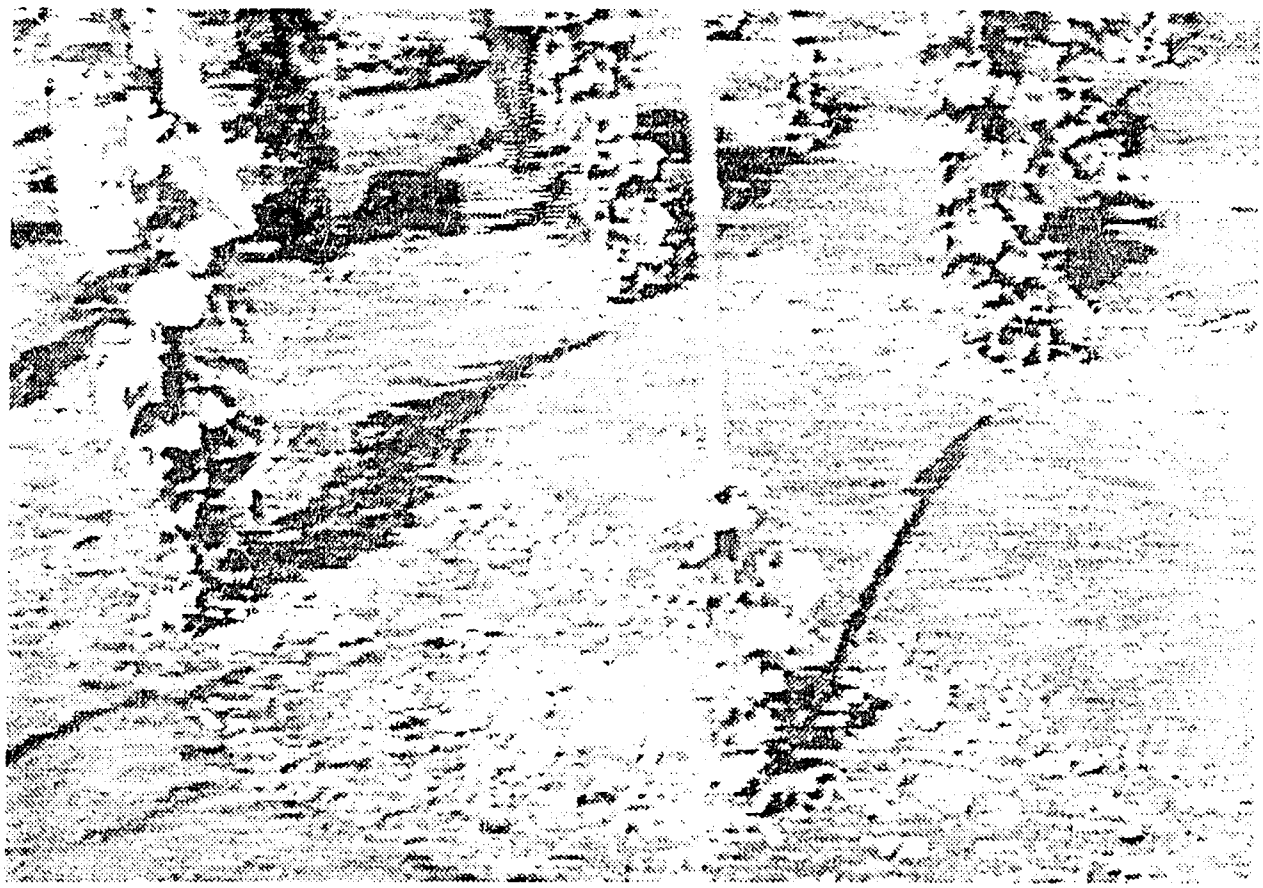
to endposts and anchor wires when equipment turns at the end of rows. Number vineyard rows so that work assignments, irrigation schedules, etc., can be understood and sites located easily.

2. Planting the Vines

Plant vines in January or February. Early planting results in good root growth before buds begin to grow in March or April.

roots and tops with soil. Do not heel-in vines with straw because they frequently become too dry.

A second method is to store the new vines in a refrigerator. If so, pack the roots in moist, but not wet, sawdust or sphagnum moss. Wrap the tops in polyethylene. Refrigerators are very dry and serious vine loss can occur if drying out is not prevented.



a. Purchase Healthy Vines. The vine stem should be at least 3/8 inch in diameter. Vines smaller than 1/4 inch are weak and can have problems surviving. They should have healthy, white to tan colored roots at three or more nodes. If plants are received with black roots, return them to the nursery or discard. They should be certified as disease-free. Instruct the nursery on how to pack and ship the vines. Roots should be in contact with a moist, not wet, packing material during shipment. The total package must be sealed in polyethylene film.

b. Heal-In to Prevent the Unplanted Vines from Drying Out. Once you receive the vines, do not allow the roots to dry out. Immediately after the vines are received at the vineyard site from the nursery, place in a shaded location and heal-in the vines by covering

c. Trimming the Unplanted Vine. On the day vines are to be planted, remove them from the heel bed or refrigerator and trim. Use high quality, hand pruning shears for this task. Cut the top growth back to a single spur with only two buds. Make the cut through the third bud.

d. Handling the Vine. In moving vines from the heel bed to the trimming room and then to the vineyard, take special care to prevent roots from drying out. Place vines in 5-gallon buckets half full of water. Move the vine directly from the bucket to the planting hole. Never spread or line out the plants on the soil surface before planting, as exposure to the air for a very short time can kill or weaken the vine.

e. Digging the Hole. Use a hand post hole digger or shovel to dig the hole. Dig the hole approximately 6 inches in diameter and 8 inches deep or just large enough to receive the root system.

f. Planting the Vine. Plant the vine so that it is at the same depth as it grew in the nursery row. Pack the top soil firmly around the spread roots. If the vineyard has been prestaked, the spur above the stem should be very close to the stake so it can be tied to the stake. Irrigate the vine immediately after planting until the root zone is thoroughly soaked.

3. Trellis Construction

As a grower plans his vineyard, he is faced with the decision of erecting the trellis the first year before planting or the second year after the vines have grown in place for 1 year.

a. Trellising the First Year. Advantages of first-year trellising are that the vines can be placed immediately adjacent to the stake, and the drip irrigation system can be placed in its permanent location on the trellis.

b. Trellising the Second Year. Advantages of trellising the second year are the economic savings on the trellis for 1 year. Planting without a stake is considerably easier and faster, thus making it more economical. Stakes are anchored stronger when placed the second year because the planting hole is not dug next to the stake, but rather the stakes are driven into their desired location. Do not delay trellis construction beyond the second year.

4. Construction Procedure

The vineyard is lined out and planted the first year. It is staked the first or second year and then endposts are set and anchored. Following this, all holes for the intermediate posts are dug. Next, one wire is stretched from end post to end post. Intermediate posts are set, and stakes are driven into the ground and attached to the wire. In this way, they can all be lined up straight down the row.

Construction of the grape trellis is very similar to the construction of a farm fence. Careful planning is required since the structure must be strong enough to carry heavy loads of vines and fruit, as well as withstand winds when fully loaded.

Trellis construction is similar for all conventional grape training systems, although they may vary in detail. In essence, trellises are all the same, consisting of end posts, stakes and wires that are strung between them. In Texas, intermediate posts may be installed where wind could blow the trellis down.

Two wires are most common, but some growers find that three wires are needed to support the vines.

a. End Posts. The first step in the construction of a trellis is the setting of solid, immovable end posts. End posts should be 6 to 8 inches in diameter because they must serve as anchor points as well as wire supports. It is best to use durable posts of cedar or pine treated with creosote, pentachlorophenol or CCA. Do not use secondhand railroad ties or telephone poles because they rot prematurely. Wooden posts should be full length pressure treated. They are more expensive but have a longer life. The cost of labor and equipment to replace posts can be expensive.

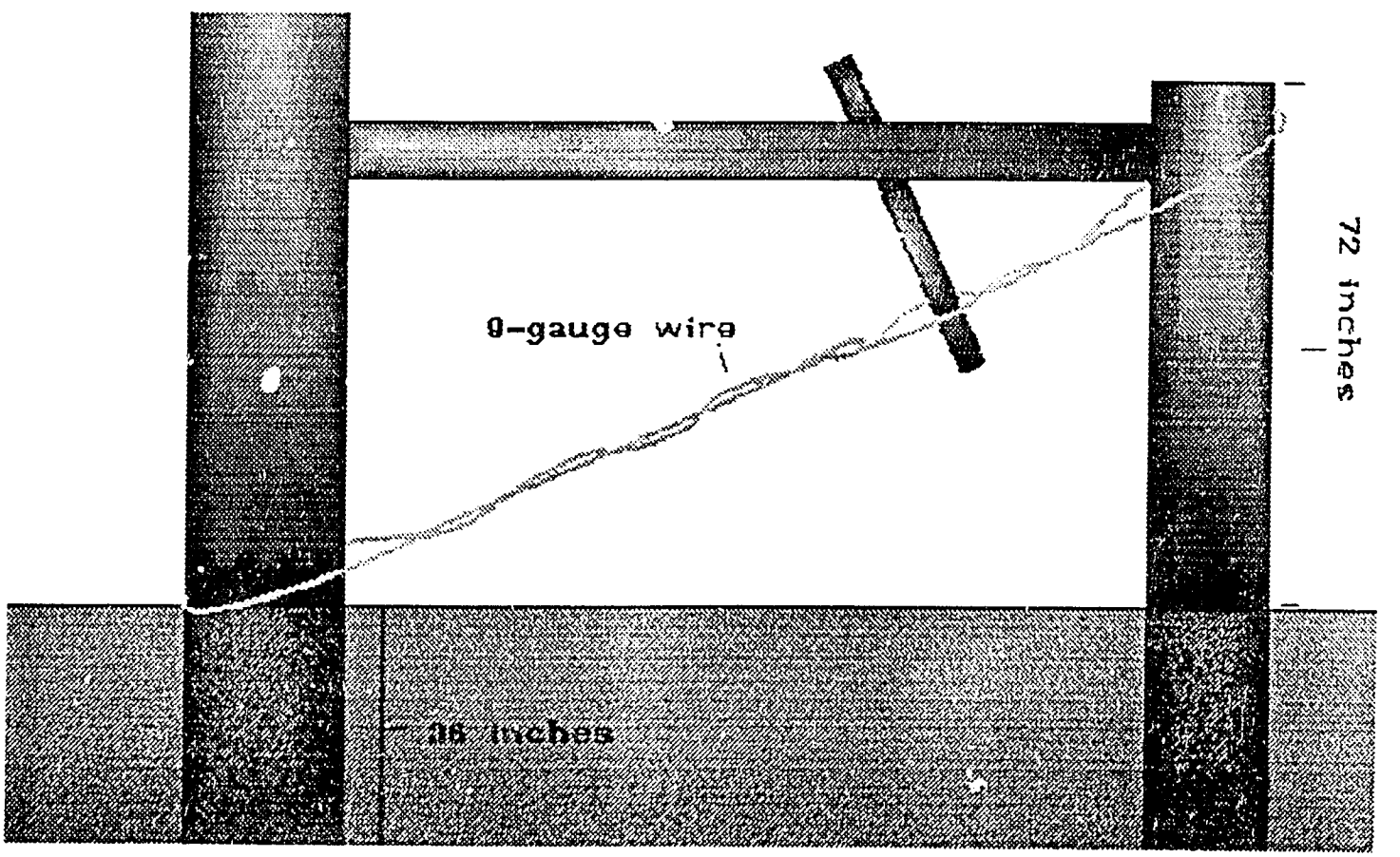
Posts of concrete properly reinforced with steel rods are very durable and can be used.

The number of the row should be marked on each end post.

b. Bracing Methods. The end posts must be securely braced as the trellis is no stronger than its end post. Three common methods of bracing include the "H" system, inverted "V" system and "vertical end posts."

The "H" or double post system is commonly used in fencing. Two posts are set at least 6 feet apart with a horizontal cross member placed 12 inches from the top of the posts.

A heavy piece of wood, 3 x 4 inches or larger, makes a good brace between the two posts. The posts are set 3 feet in the ground. A #9 wire is then doubled and wound between the base of the end post and the top of the inner post. The wire is tightened by twisting with an iron or wooden rod and latching it behind the nearest post or cross member to prevent the brace wire from unwinding. The brace wire also prevents the end post from becoming loose and lifting out of the ground. An advantage of this system is that it avoids the use of anchor wires beyond the end post. The inverted "V" system is commonly used for high trellises and arbors. It consists of a 9- to 10-foot long end post set at approximately a 60 degree angle rather than upright, with the base set about 3 feet into the ground. The top of the post is then tied with #9 galvanized wire to a large "deadman" placed 5 feet in the ground. Various objects such as rocks, concrete blocks, poured concrete or sizeable metal objects make excellent anchors or "deadmen." However, in rock-free soil an anchor screw can be turned into the soil at a 45 degree angle, pointing toward the top of the endpost.



The "V" system is strong and resists considerable pull when properly constructed. Failures are experienced if the angle of the pull on the "deadman" is overly vertical. If the "deadman" is placed further out so that the wire pulls at more than a 60 degree angle, it reduces the hazard of lift. A second weakness is corrosion of the wire at the ground line. However, this problem is reduced by utilizing a steel rod from the "deadman" to about a foot above the ground. The wire is then attached to a rod instead of directly to the "deadman." Another problem is that the size of the turn rows must be increased to 30 feet to properly turn equipment at the end of the row.

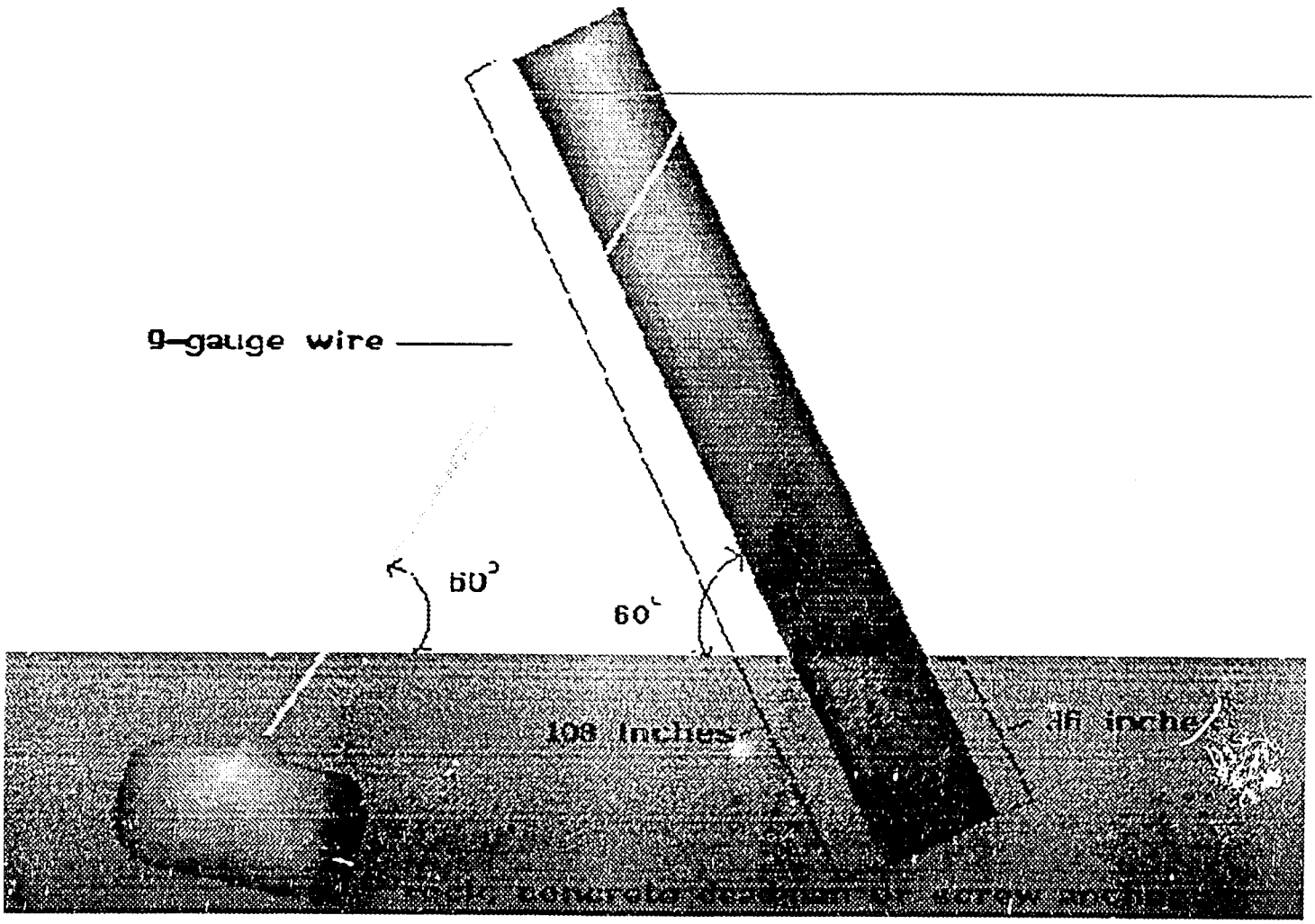
Vertical end posts are a slightly less expensive way to anchor trellises. Rather than manually setting end posts at an angle, they can be set vertically and anchored by a rod or heavy wire on a 45 degree angle to a "deadman." They are at least 3 feet in the ground.

As with the inverted "V" the primary disadvantage of the vertical end post system is the vulnerability of the supporting wire to damage by vineyard equipment. This hazard is minimized by placing a marker post where the wire enters the soil.

c. Intermediate Posts. Intermediate posts may be made from the same type of materials used for the end posts. However, they need not be as large since they do not carry the strain as end posts. Rather, they help stabilize the trellis and keep it from blowing over. Intermediate posts are usually 4 inches in diameter and are placed every 10 vines or 80 feet.

d. Stakes. Stakes are placed at every vine down the row. Various materials can be used for stakes, including 8-foot x 2-inch cedar stakes, mahogany stakes, pentatreated stakes, wolmanized stakes or steel grape stakes. Wood stakes should be knot-free and full length pressure treated. Stakes are generally set 18 inches deep using a stake driver.

e. Wires. High tensile, 12- or 13-gauge galvanized wire is commonly used in Texas. While more expensive initially, it is more durable and may be the least costly over a long period.



f. Connecting wires. Wires may be secured to end posts in various ways. A common method is to wind the wire around the post at least twice and then twist the end several times around the wire. Some growers use special devices such as turn buckles to attach the wires to the end posts because they simplify tightening the wires. Other systems use a hole through the end post with a wire vice to prevent the wire from sagging.

Wires are fastened to intermediate posts and stakes with fence staples, grape wire clips or wire ties. Drive staples far enough to hold the wires close to the post, but with enough play that the wire will slip through when tightening is needed. A light gauge wire may also be used to tie the wires. With steel posts, wire fasteners are used. Hang wires on the windward side or on the uphill side of posts.

Space wires vertically according to the training method to be followed and the height of the finished trellis. The 42-inch wire is usually connected first.

g. Cordon Trellis. Using the bilateral cordon system, place the cordon wire at 42 inches and the upper wire at 66 inches above the ground. A "catch wire" of 13-gauge is fastened at 52 inches to train the vertical arms in an upward manner. An alternative to a single wire at 66 inches is to place a crossarm with two wires at that height. This provides for better utilization of sunlight and mechanical harvesting. A drip irrigation wire is sometimes used at 18 inches.

h. Cane Trellis. The cane training system will have wires at 42 and 66 inches above the ground.

i. Table Grape Trellis Designs. Trellis systems for table grapes generally require a crossarm attachment to a 6- or 7-ft. (1.8- to 2.1- m) stake. This system is very common on cordon-trained spur-pruned table grape cultivars. For cane-pruned table cultivars, some growers use a 36- to 42-in. (91- to 107-cm) crossarm and tie fruiting canes directly onto the attached wires. Others go to a more elaborate system employing two crossarms and a cordon wire. The cordon wire is attached to the 7-ft. (2.1-m) stake 42 in. (107 cm) above ground. An 18- to 24-in. (46 to 61-cm) crossarm is placed 12 to 14 in. (31 to 36 cm) above the wire with another 36- to 42-in. (91- to 107-cm) crossarm being placed about 12 in. (31 cm) above the first crossarm. For those cultivars requiring a great deal of handwork, such as girdling, thinning, leaf pulling, and so on, this system works well. It also facilitates hand harvesting by causing fruit clusters to hang separately.

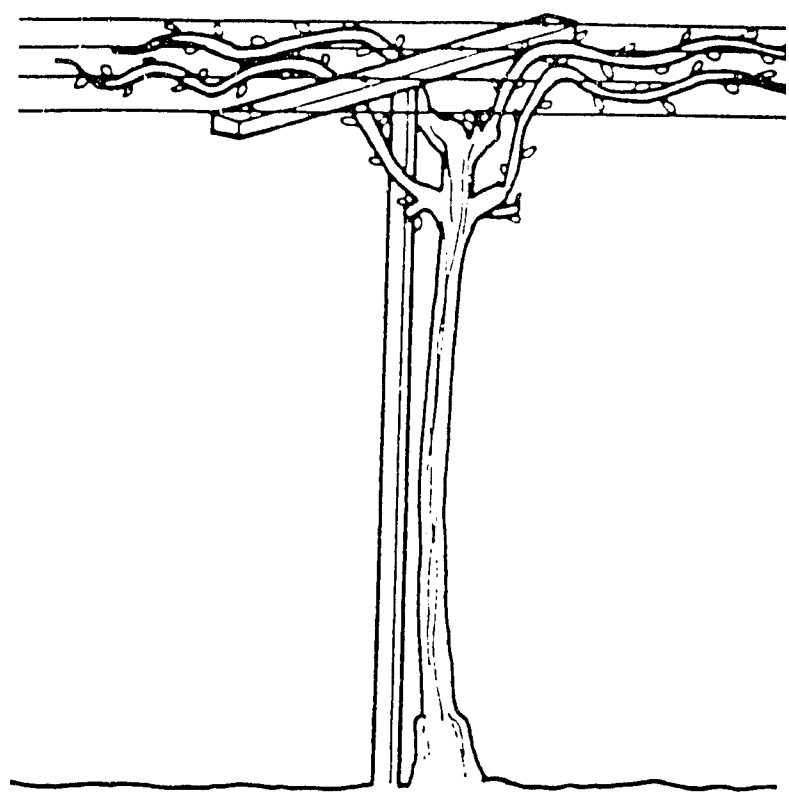
j. Trellis Maintenance. Trellis wires should be slack in the fall. If taut, contraction of the wires during cold periods puts a severe strain on the trellis. Generally, the wires have stretched sufficiently so that loosening is not necessary. Tighten the trellis wires each spring. The best time to do this is after pruning but before growth, when the canes are tied to the wires.

B. Vine Training

The purpose of training is to shape the vine into a form that optimizes productivity and facilitates management practices.

Around the world there are various types and versions of training. The two common training systems used in Texas are the cane method and the cordon method.

The primary purpose in both of these methods is to establish an upright, single trunk with either side canes or side cordons. A trellis is needed to support the vine. Vines are trained on the trellis during the first 3 years. During this period, most of the yield that could have been harvested is sacrificed to achieve effective vine training and maintain maximum vine health. No grapes should be produced the first or second year, a light crop the third and only one-half crop the fourth year.



HEAD TRAINED CANE PRUNED

To understand how to train a vine, names of the various parts of the grape vine must be understood--cordon-trained vine and cane-trained vine.

Terms used in vine training include the following:

* Trunk - the main vertical stem, body of the vine.
* Cordon - a horizontal extension of the trunk.
* Vertical Arm - an extension of the cordon containing the spurs.
* Shoot - the present season's growth, containing the leaves and fruit clusters.
* Cane - a dormant 1-year-old shoot without leaves.
* Spur - a cane which is cut back to two or three buds.
* Sucker - an undesirable shoot which comes from the trunk.
* Water Sprout - a vigorous, non-fruitful shoot from upper part of the vine.

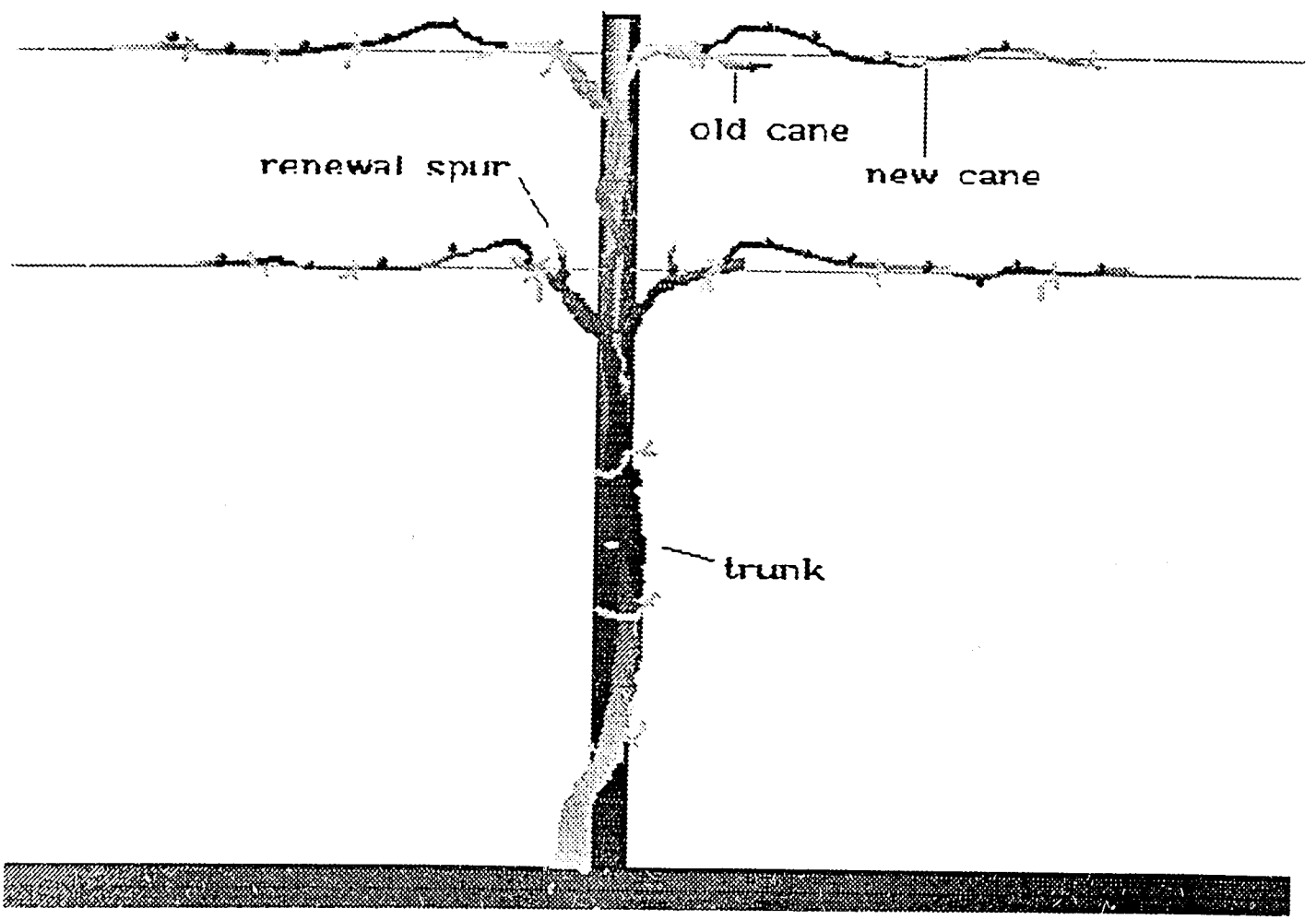
It is necessary to repeat tying, pruning and disbudding several times in the second and third summers. Always leave all foliage on the leading shoot and cordons to provide photosynthetic needs.

Always try to first select the shoot or cane you want to train: tie it and then remove unnecessary shoots. This way, if the selected shoot breaks, you can replace it.

When cutting back shoots or canes, make the cut through a bud one node beyond the desired bud.

Ties on shoots should always be semi-loose to permit stem enlargement. A polyethylene tape, commonly used with a tapener, is a good choice for tying. Other common plant ties may also be used. Tying materials should be elastic or biodegradable.

Do not tie the first 18 inches from the tip of a growing shoot. This growth is very tender and easily damaged.



An experienced member of the training crew or crew chief should be responsible to see that the vines are properly trained on a constant basis.
If a laborer is pruning or tying the vines improperly, he should immediately be taught the proper way. The crew chief can pay bonuses to laborers who do the best work in the shortest time. Other workers are then encouraged to work faster and do the job correctly. Each person should work down an assigned row.

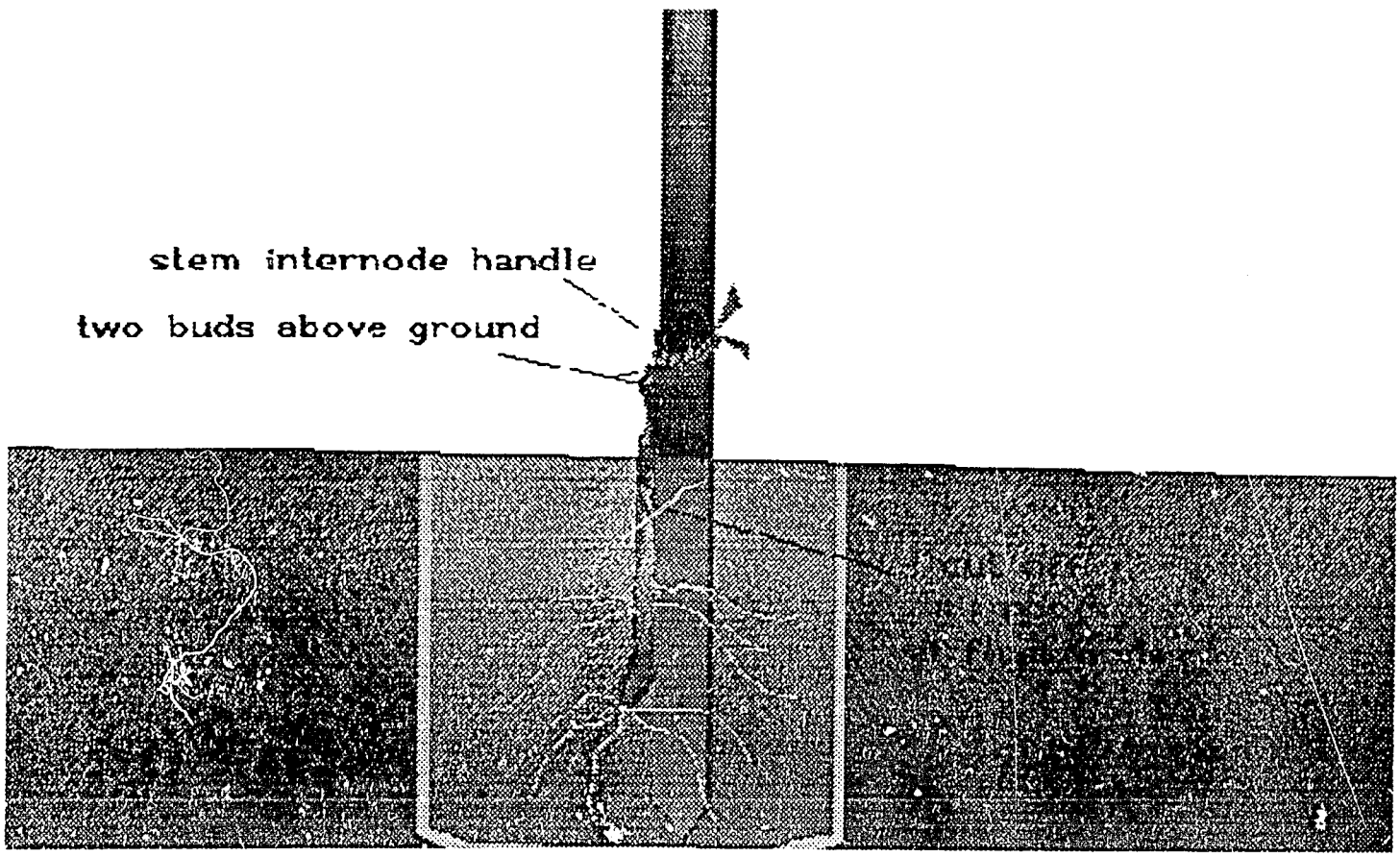
1. Training Begins at Planting

Remove all shoots except the most vigorous one and cut it back to two strong buds. Make the cut through the third bud. If the vineyard is staked, tie the stem internode handle to the stake.

to the stake. Cut this cane to a length of two buds. Make the cut through the third bud. If the vineyard is staked the second year, tie the plant to the stake after pruning. Tie the stem internode handle above the second bud to the stake.

Soon after growth begins in spring, select a strong shoot which is close to the stake to build the trunk. The selected shoot should be 12 to 18 inches long. Tie the selected shoot to the stake, then remove the other shoots.

Tie the trunk shoot to one side of the stake four to six times during the season to develop a straight trunk. Remove lateral shoots but not the leaves on the lower 30 inches of the trunk. As rapid growth begins, this training may be needed as often as once a week.



2. Cordon Training

a. First Year. The primary objective in the first year is the development of a healthy and strong root system. Therefore, do not interfere with growth during this season by pruning or training the vine. This may seem unusual, but it is necessary.

Beginning the second year, the vine receives either cordon system training or cane system training. Each of them is discussed separately.

b. Second Year. In the winter after the first season, prune off all top growth except the cane closest

When the trunk shoot reaches the top of the stake, cut the shoot through the node nearest the cordon wire.

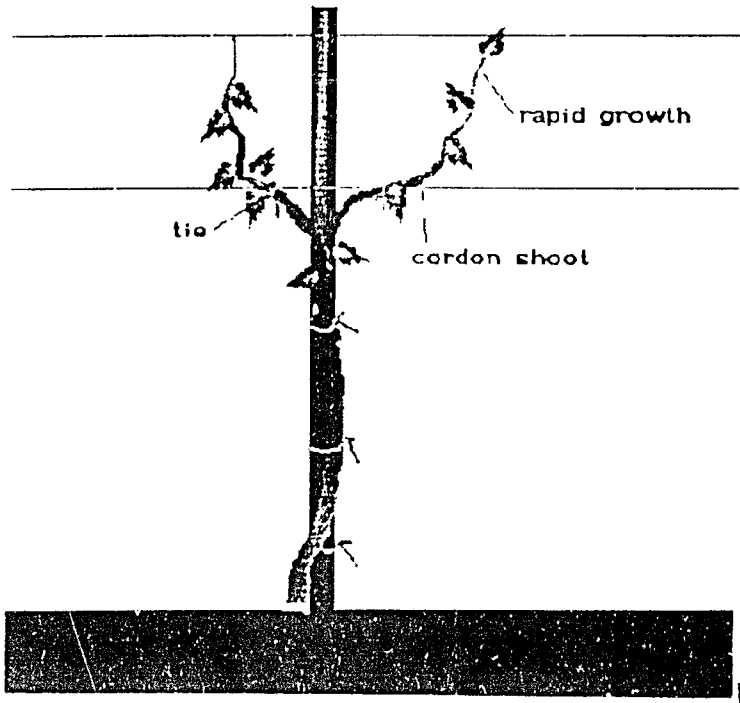
Tie the stem internode handle to the stake. Make sure the trunk is tied to the same side of the stake as the wire attachment. Lateral shoots will force along the trunk. Select two shoots which are branching off about 6 to 10 inches below the lower wire. Do not remove the remaining laterals until selected cordons are established. Do not remove the leaves from the trunk but remove all other

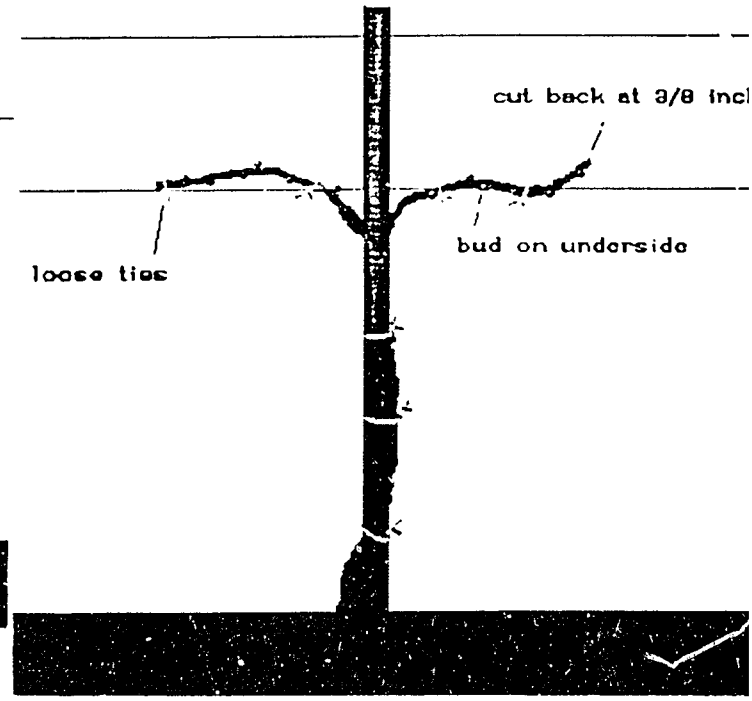
lateral shoots. Never pull the top over to form only one half of a cordon. Also do not leave more than one cordon on each side.

When the two laterals are 18 to 24 inches long, tie them on the cordon wire on both sides of the trunk. These cordon shoots will become the cordons.

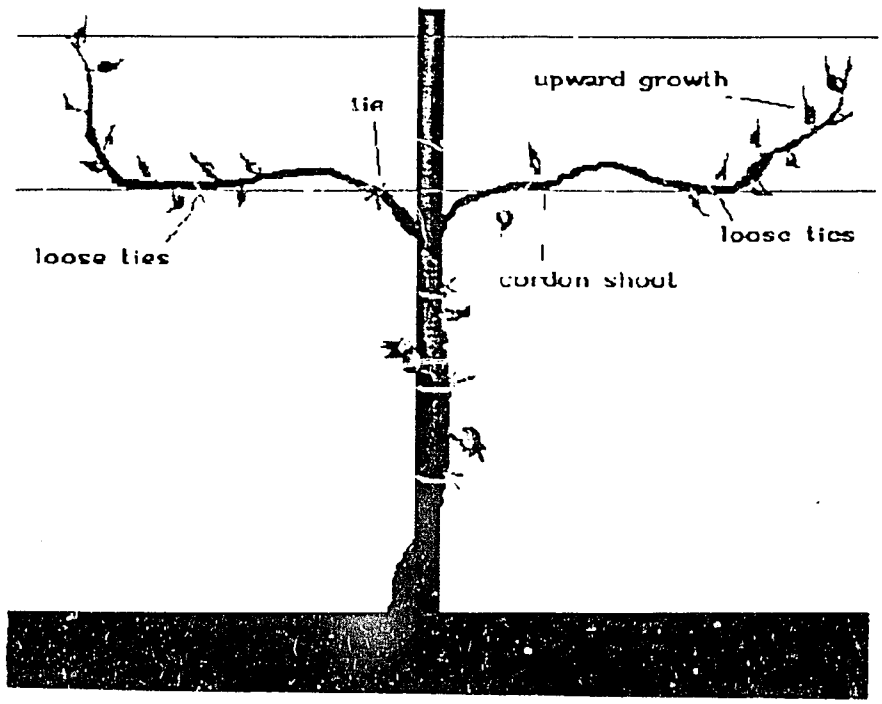
To prevent injuring the tender shoot, tie the cordon shoot at least 18 inches from the growing tip. Rub off all fruit clusters if they develop.

If growth is very rapid and the cordon shoot reaches 3/8 inch diameter at 42 inches from the divide during the second growing season, cut the cordon shoot at that point. This encourages lateral shoot growth.

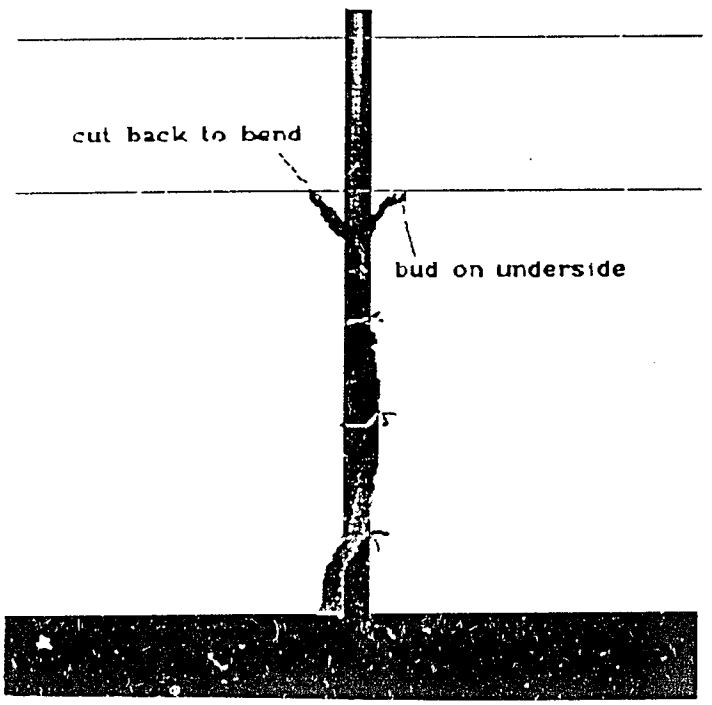




Allow the tips of the cordon shoots to grow upward. As the cordon shoot grows rapidly, tie it to the cordon wire.

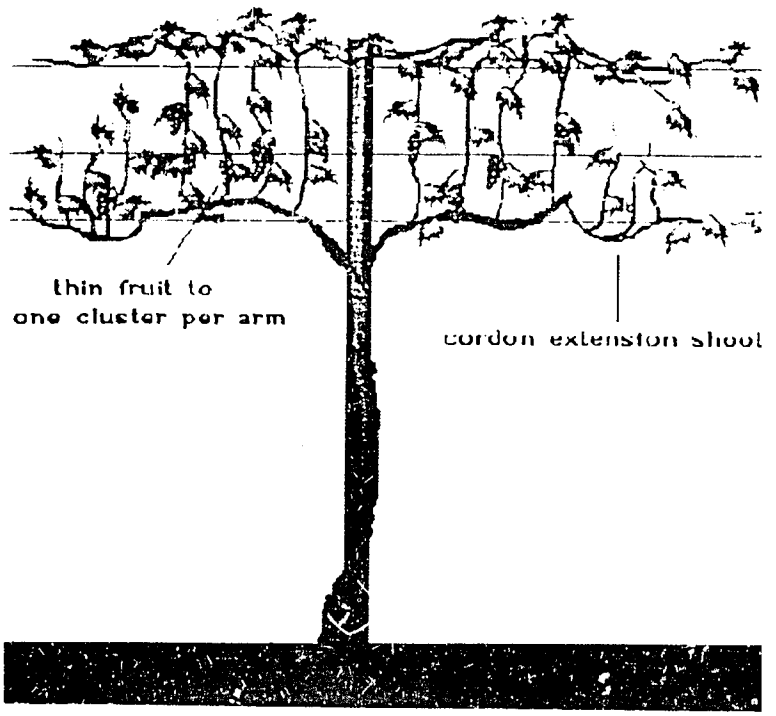


c. Third Year. Cordon canes not previously cut and tied at 42 inches are cut back to 3/8 inches diameter during the winter before the third year's growth. This encourages maximum lateral bud break and uniform growth of the spurs which form vertical arms. For future extension of short cordons, make the cut next to a bud on the underside of the cordon cane. This prevents a drastic bend when the extension shoot is tied to the wire. Gently bend the cordons around the cordon wire one and one-half turns. Use a semi-loose tying to maintain a straight cordon.



At this point, the vine should have the general form of the vertical trunk with horizontal cordons. Length of the cordon varies with the vigor of the vine.

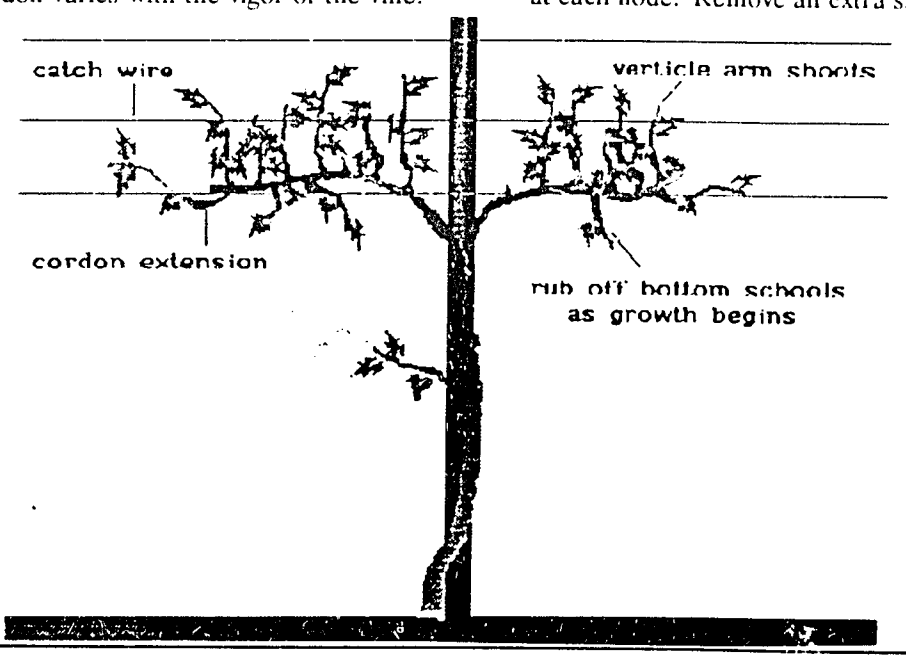
Growers should not attempt to build cordons from canes less than 3/8 inches in diameter. On weak wines where the cordons are fewer than 6 inches beyond the bend, cut them back to a lower side bud a few inches from the divide.



The objective of the third growing season training is to establish vertical arms of each cordon.

When growth is rapid at the beginning of the season, rub off any shoots developing on the underside of the cordons.

On each cordon select vertical arm shoots developing on the upper side which are spaced 5 to 7 inches apart. There may be more than one shoot at each node. Remove all extra shoots and suckers



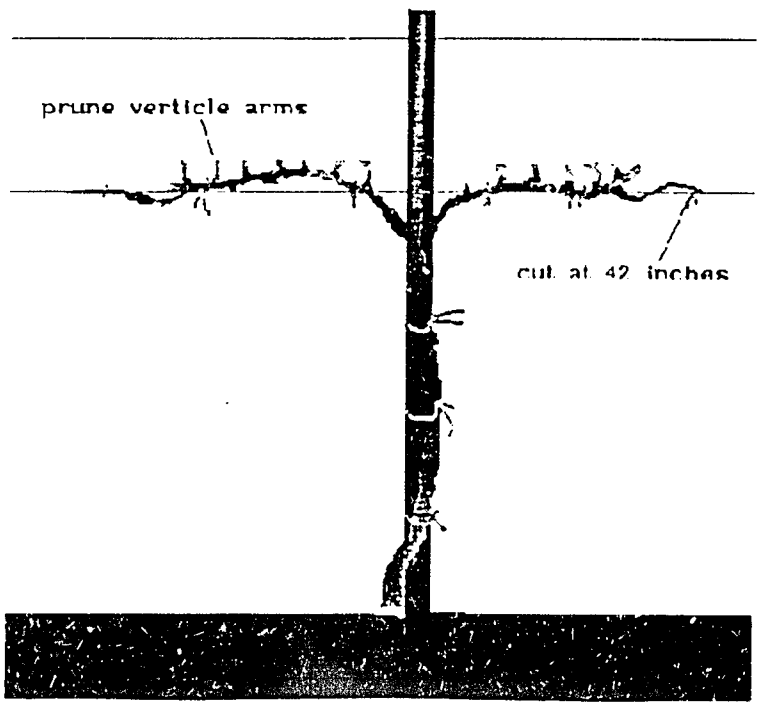
arising from the trunk.

Tie the selected vertical arm shoots to the catch wire, 10 inches above the cordon wire, as soon as they reach a length of 18 inches.

Directing these shoots straight up and tying them is extremely important to prevent cordons from twisting over due to the new growth's weight. The catch wire can be a 13-gauge wire. Its only purpose is to direct the vertical arm shoots upward.

Allow only one cluster of fruit per shoot during the third growing season. Tie the cordon extension shoot to the cordon wire.

d. Fourth Year. In the winter before the fourth year's growth, cut the vertical arm cane back to a spur of two buds.



Maintain uniformity in spacing and size of spurs. The vertical arms develop on the base of these spurs, and it is important to make sure that they are directed upward. If there is no cane on the upper side where a spur is needed, use a cane from buds on the side of the cordon. In this case, cut the spur to one bud and tie the developing shoot vertically to the catch wire during the growing season. Remove all other canes, including growth beyond the 42-inch point or halfway to the next vine. Do not retain any canes on the bends or divide of the cordons. If necessary, untie and retie the cordons to avoid sagging.

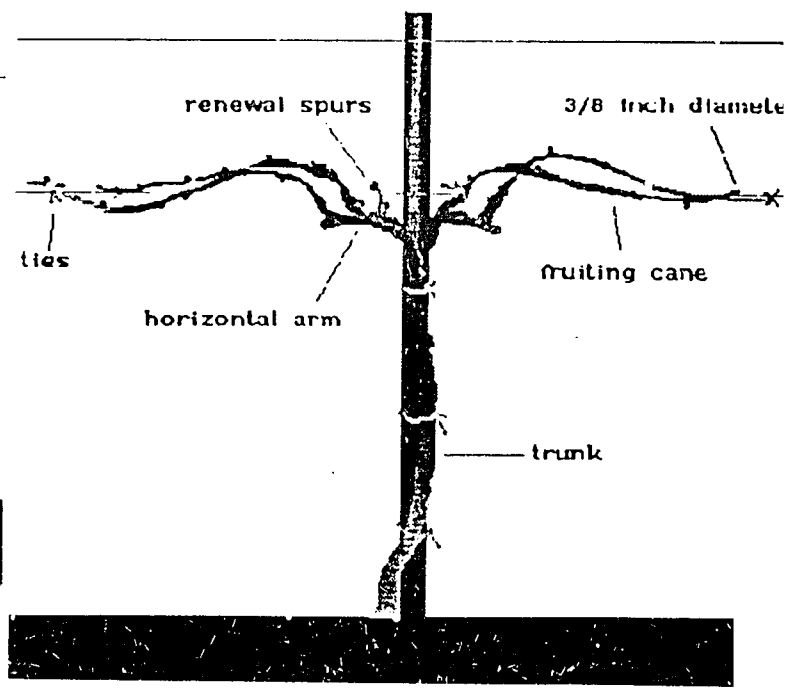
During the fourth growing season, thin the clusters, leaving only one cluster on each vertical arm shoot. Vertical arms on the cordon extensions should only have one cluster per shoot.

Maintain and perfect the vine's horizontal cordon and vertical arms in the following years. The cordons may "wrap" the wire and become self supportive.

3. Cane Training

Most table grape varieties are cordon trained and pruned, but certain varieties such as 'Thompson Seedless' must be cane pruned for good production. Cane pruning is recommended for varieties that do not produce fruit on the basal buds or that have poor fruit on the lower buds of the canes.

The objective of cane training is to form a single, vertical trunk with four canes rather than cordons. There will be two canes at two wires, one on each side of the trunk. One cane training method places one or two canes only on the lower wire on each side of the trunk.



a. First Year. The first year, prune the vine back to two buds at planting.

The vine is allowed to grow at random on the ground throughout the growing season.

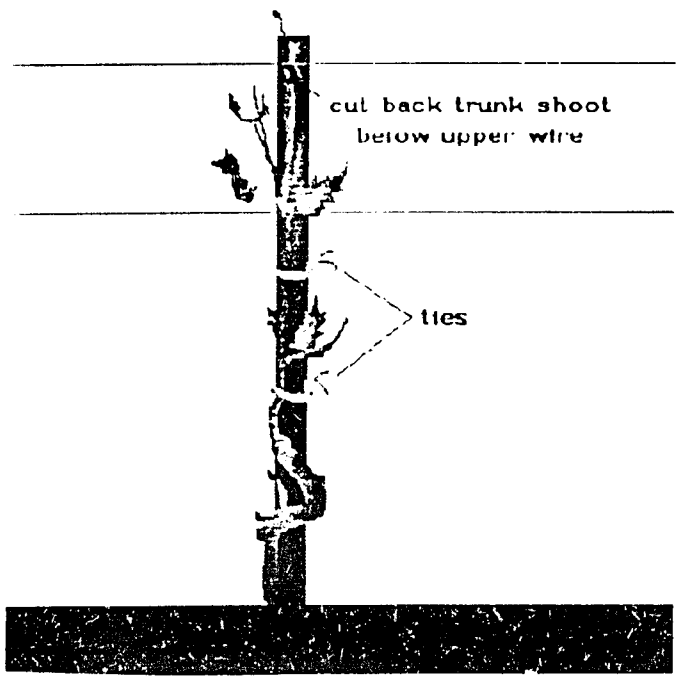
b. Second Year. The vine is pruned back to two buds in the dormant season before growth begins the second year.

Growth begins in the spring with two to ten shoots growing rapidly. Select the strongest shoot having the best position and tie it to the stake.

Once this shoot is fully established and is in no danger of breaking off, remove the other shoots.

The shoot selected as the trunk will grow very rapidly. Tie the trunk shoot to the stake every 10 inches. This insures a straight trunk very close to the stake. As lateral shoots develop on the lower 24 inches of the trunk, cut them off.

When the trunk shoot reaches the top of the stake, cut it 6 inches below the top wire. This encourages lateral shoot growth along the trunk.

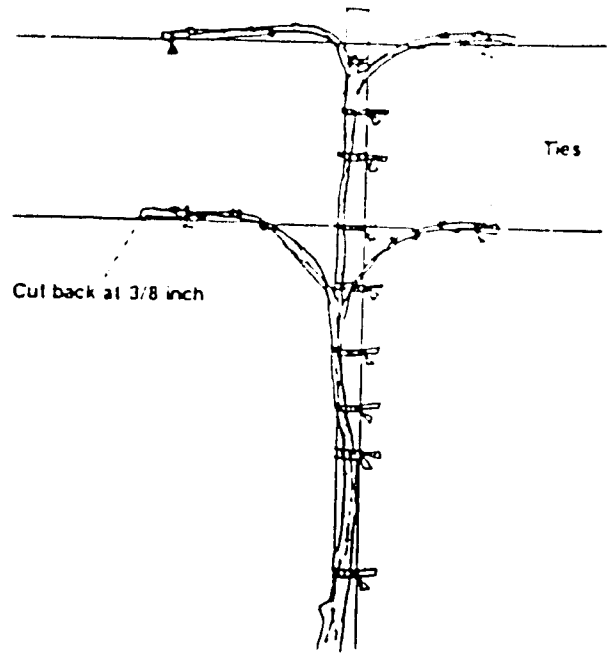


Select four lateral shoots, two at each wire. It is ideal to have one shoot on each side of the wire and 6 inches below it. The two top canes should develop at least 6 inches below the upper wire. If they are higher, they become strong, shading and weakening the lower canes.

Tie the shoots on each side of the trunk to the wire. Tie the lateral shoots at least 12 inches from the growing tip.

c. Third Year. In the winter before the third year's growth, prune back the four selected lateral canes at a point where they are 3/8 inch in diameter. This could be as short as 4 inches on one vine or as long as 24 inches on another vine. However, it is important for all four to be approximately the same length on a particular vine. This short cane develops into the horizontal arm over the years.

During the growing season, allow growth from all buds. Remove any suckers or shoots arising from the lower trunk. Avoid overcropping in the third year by leaving only one cluster per shoot.



d. Fourth Year. In the winter before the fourth year's growth begins, develop four horizontal arms. Each horizontal arm should have one fruiting cane and one two-bud renewal spur. The fruiting cane should be 42 inches long or cut at a point where it is 3/8 inch in diameter. Do not leave a fruiting cane that is smaller than 3/8 inch in diameter. The fruiting cane is growth which is only 1 year old. The renewal spur should be as close to the trunk as possible. Remove all other canes.

From the fifth year on, pruning is done to select one fruiting cane and one renewal spur from the horizontal arm each year before growth begins.

C. Pruning

Grapevine training is the development of young vines into a desirable form, and pruning maintains the established form. The purposes of pruning are threefold: (a) to regulate the amount of fruit produced during the growing season, (b) to direct fruiting to the proper place on the vine and (c) to maintain the vine in a form that facilitates management practices. To achieve these purposes, one must have some basic knowledge of the growth and fruiting habits of grapevines.

1. Growth and Fruiting Habits

Grape clusters form on the current season's shoot. These shoots, on which clusters are borne, develop from buds formed the previous summer and left on the canes after pruning. Shoots more than

a year old are nonproductive and should be pruned. Canes which are small in diameter are not as productive as those of about 3/8 inch diameter.

A shoot developing from one bud may produce up to six fruit clusters, but usually only two to four develop. This depends upon variety, age and management practices.

When fewer shoots are allowed to develop, each remaining shoot becomes more vegetative. Terminal buds and those which are higher, relative to other buds, are more vigorous and break out first in the spring. It is, therefore, advisable to keep all buds on a cane or cordon at the same level.

The grapevine is a highly reproductive plant and produces far too many fruit if it is not pruned properly. A heavily cropped vine cannot allocate sufficient reserves to develop a crop and mature shoots properly. Overcropping increases susceptibility of the vine to drought and cold.

2. Time of Pruning

Mature vines from the fourth year on may be pruned anytime between leafdrop and bud break in the spring. In Texas, this period is December to March. The specific time of pruning within the dormant season has no apparent effect on the vigor of the vine. In small vineyards where the work may be done in a short time, it is advisable to delay pruning until late winter. This delays bud break somewhat and thereby reduces the hazard of a spring freeze. Pruning after growth starts may cause an excessive flow of sap from the cuts. In fact, bleeding may occur at pruning in mid-winter if fine roots have been stimulated into growth following warm weather. This loss of liquid is usually not injurious to the vine.

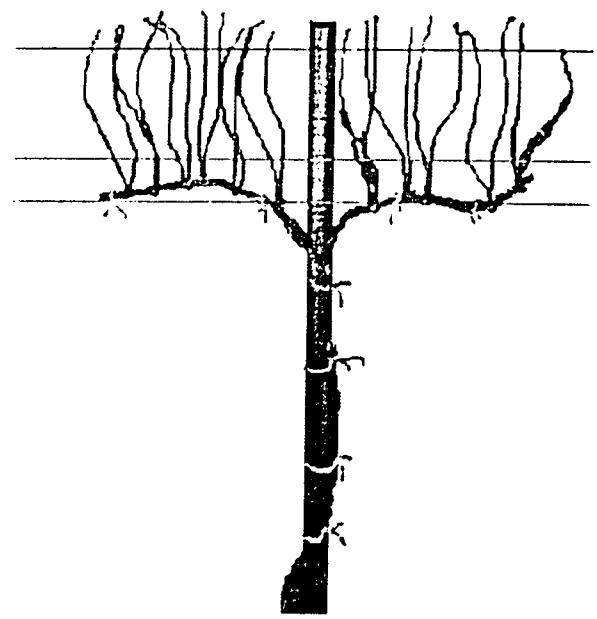
Major summer pruning is usually not recommended for mature vines. Heading back vigorous shoots is wind breakage. Low hanging shoots are commonly cut back in the summer to facilitate herbicide applications and harvesting. Late summer pruning can result in new growth and freeze injury.

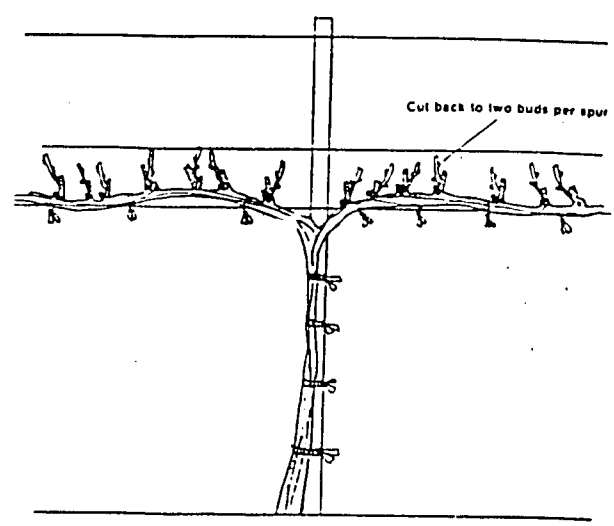
3. Pruning Principles

Regardless of the system used, the overall pruning objective is to produce a balance between yield and growth. Large, healthy vines can generally support 40 buds. However, the best rule to follow in determining the number of buds to leave is to observe the previous year's performance. If a large, well-matured crop was produced the previous year, leave the same number of buds. But if the vine was overly vegetative with a less-than-expected size crop, leave more buds. If a large crop of poor quality fruit was produced, encourage more vegetative growth by reducing the number of buds. When reduction is necessary, it is usually not wise to eliminate arms or spurs, as they are hard to replace. Rather, it is better to reduce the number of buds on each cane or spur. Therefore, to properly prune the vines a laborer needs a knowledge of the vine's previous performance.

4. Cordon System

The cordon system is easy to prune, although it is difficult to train. The vine has two horizontal branches or cordons, one on each side of the main trunk. Seven vertical arms with two- to three-bud spurs are spaced 5 to 7 inches apart on each cordon. Growth for the next year comes from the buds left on these spurs.



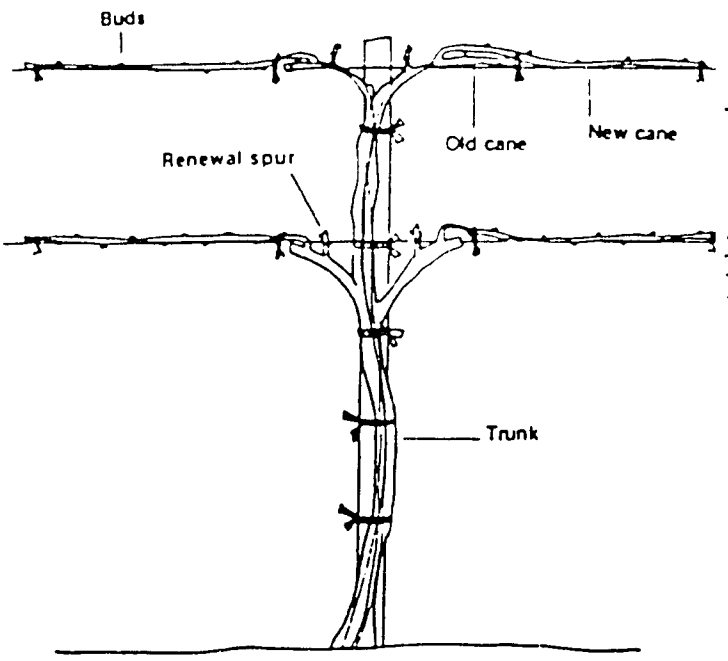


Hence, the objective every winter is to cut an unpruned cane back to a two- or three-bud spur to maintain an adequate number of buds per vine. Generally if a cane is weak, leave one bud; if normal, leave two buds; and if vigorous, leave three buds. Once that number is determined, remove all other canes from the vertical cordon arms and the main trunk, including suckers.

5. Cane System

With the cane training system, the vine is trained to four canes and a renewal spur for each cane. Hence, every winter leave new canes and spurs for the coming growing season.

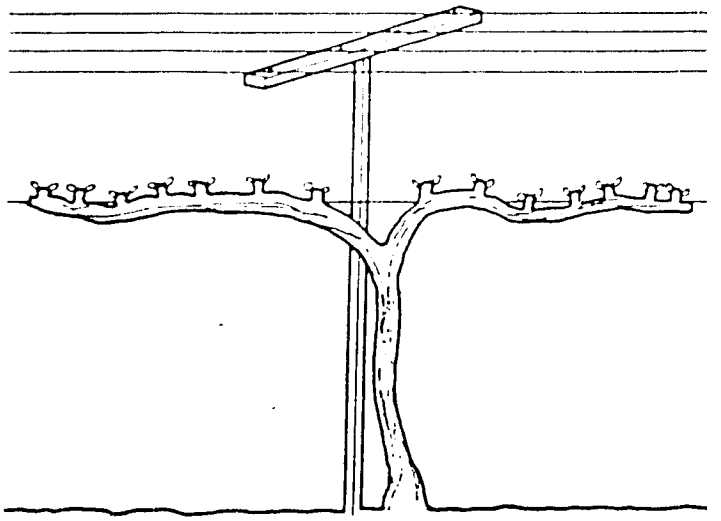
The two-bud renewal spurs from the previous season should each produce two good canes. Usually the uppermost cane on the spur would be left for the fruiting cane and the lower one cut back to two buds to form the new renewal spur. However, this may not always be the case. If good canes cannot be obtained from these, then use canes developing near the base of the renewal spur.



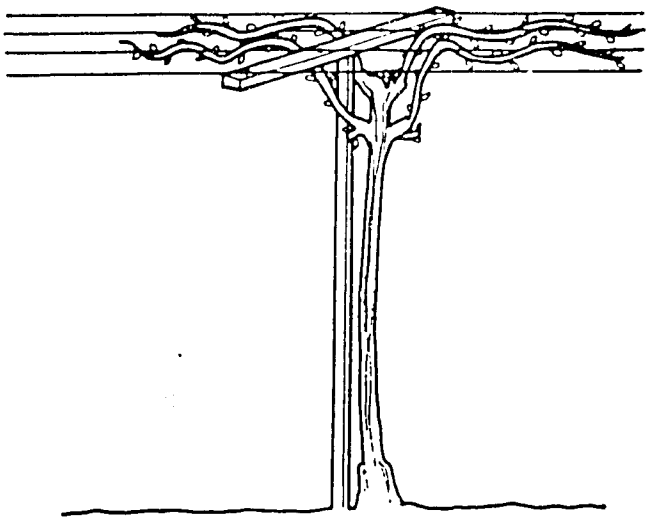
Length of the canes selected depends on individual size. Ideally 10 buds per cane could be left. However, large canes of a half inch or more in diameter may be left to a maximum length of 15 buds; smaller ones should have fewer buds. Hence, the number of buds left per cane depends on the cane's diameter. The end of each cane should be at least 3/8 inch in diameter. Thus, certain canes may have more buds than others, even within the same vine, to obtain the total number of buds desired. Once the four canes and renewal spurs have been selected, remove all other growth including suckers and the old fruiting canes. Finally, tie the new fruiting canes to the trellis wire.

D. Common Training Systems

The pictures below show two of the most common training and pruning systems used for table grapes. Note that each system uses a T-bar trellis system with four horizontal catch wires.



BILATERAL CORDON SPUR PRUNED



HEAD TRAINED CANE PRUNED

E. Disposal of Prunings

After pruning a vine or section of the vineyard, place the prunings between the rows.

Carefully remove prunings from the trellis to avoid breaking the canes retained for producing next year's crop. It is ideal to remove the prunings from the vineyard and burn them. Many vineyards shred the prunings in the middles, thus reducing some of the labor cost for this operation.

F. Weed Control

Grass and weeds are probably one of the biggest problems in establishing and managing a vineyard. If weeds are not controlled, they compete for water and nutrients as well as harbor insects and disease. They also hamper cultural operations, especially those where hand labor is involved, such as vine training, pruning and harvesting. Weeds are controlled with mechanical cultivation, herbicide applications, mowing or combinations of these.

1. Preplanting Weed Clean Up

To reduce weed control problems use good vineyard row preparation before trellising and planting. Reduce all perennial weeds such as johnsongrass and bermudagrass before planting. This is done by deep plowing and disking during drought or freezing weather. Perennial weeds can also be greatly reduced with contact herbicides at a strong concentration in September or October before planting the next spring. It is far easier to kill weeds before planting than after young vines begin growing in the spring.

2. Mechanical Weed Control

Cultivation is the most common method for controlling weeds in grape vineyards.

Simply plow and disk rows as the weeds begin to grow; thus weeds never become established. The soil should be moist enough to crumble as the plow moves through it. If the soil is too wet, it balls up into very hard clods when it dries. Extremely dry soil does not crumble when plowed. In vineyards where flood irrigation is used, cultivate the rows before each irrigation. In dryland or drip-irrigated vineyards cultivate after each major rain to kill newly germinating weed seeds. If frequent cultivation is not practiced, weeds can become very difficult to control.

Cultivate under the rows and in the middles, maintaining a weed-free vineyard. Cultivation is easy to do for most growers and requires little technical knowledge. However, after years of frequent plowing, a serious soil compaction layer can form in the tractor tire paths down the side of the vines.

Equipment used in Texas for cultivating vineyards includes hand hoes, disk harrows, rototillers, rotary hoes, French plows and weed badgers.

3. Chemical Weed Control

Two general types of herbicides can be used to effectively control vineyard weeds. Post-emergent chemicals kill weeds on contact, and preemergent chemicals prevent weed seeds from growing. Each of these types can be used before planting the vineyard or after the vines are growing.

a. Preplanting Chemical Weed Control. For a vineyard to get a fast start, reduce weeds as much as possible before planting. Use post-emergent, contact herbicides, which have no residual effect in October before planting, to control johnsongrass or bermudagrass stands. These perennial weeds are difficult to control, and preplanting reduction is very important. In November, cultivate the dead grass and soil in preparation for preemergent herbicide applications. Apply these chemicals in January or February before planting, building the trellis and installing the drip irrigation system. Cultivate the soil extremely well before applying the preemergent herbicides; otherwise, they will not effectively prevent weed seed germination. Incorporation is required on some preemergent herbicides. Over-incorporations or too shallow incorporations reduce the effectiveness of these chemicals.

b. Vineyard Chemical Weed Control. Vineyard weed control is a continuous process. Cultivation can be used but chemicals are frequently needed for an effective total weed control program.

Use preemergent herbicides to prevent weed seeds from germinating. For good results the area to be treated must be extremely well cultivated before applying the herbicide. Apply the preemergent herbicide in February or March before vine and weed growth begins. Do not exceed label rate recommendations for your soil type. Several preemergent herbicides should be used only on acid soils, while others need to be incorporated.

If weeds escape cultivation or preemergent herbicide control, a post-emergent or contact herbicide is needed. Protect the trunks of the vines with aluminum foil or plastic coated paper to keep the herbicide off the vine.

c. Herbicide Application. Herbicides can be accurately applied to weeds or soil through highly refined nozzle tips. Mix per acre rate of chemicals in 30 gallons of water and apply with a specific pressure and tractor speed.

G. Irrigation

Irrigation is needed on all commercial vineyards in Pakistan. This is applied either by drip irrigation or flood irrigation. Avoid sprinkler irrigation because of salinity problems and fruit diseases.

Water management is more critical in arid parts of Texas. Irrigation principles are simple, but exact rules for their application are difficult. The amount and frequency of irrigation depends on location, precipitation during the growing season, temperature, evapotranspiration rate, soil's water-holding capacity, soil's water infiltration rate and variety vigor. Install the drip or flood irrigation system before vines are planted.

1. Establishment Irrigation

Irrigation is very important the first year of vineyard establishment for maximum root system development. During the second growing season irrigation is essential for trunk and cordon development. If growth is not rapid, proper vine training is difficult. In the third year, irrigation initiates vine vigor early in the season, which continues through July to complete vine training, mature the first crop and develop strong wood for the next year's crop.

2. Mature Vine Irrigation

As vines come into production their water requirement increases. On mature, bearing vines water is essential in early spring as growth begins, in midseason for canopy development and 10 to 14 days before harvest when berry sugar is increasing rapidly. However, moderate stress during fruit maturation may enhance fruit quality.

3. Salinity

Every soil contains a certain amount of salt which may not be harmful until reaching a certain level. When salts accumulate beyond the critical level, available water to the vines is reduced.

Irrigation water has varying amounts of salt. Most of the salts remain in the soil after water is consumed. In most cases, rain leaches excessive salts below the root zone. But problems such as leafburns and yield reduction increase as the salt level in the water increases. If rain is insufficient for this purpose, apply additional irrigation water. In severe salinity cases, take special steps for soil and water management.

Remember that in irrigated vineyards o. e cannot keep a good soil indefinitely with poor quality water.

4. Irrigation Methods

Furrow irrigation is a common method used in grape production where there is an ample water supply with low salt problems and soil texture is medium to heavy.

In Pakistan, it is only adapted to relatively flat lands that can be graded to slopes of less than 0.15 percent. Generally two low furrows are constructed using tractor-mounted bedders. The furrows are reconstructed after each disking and before each irrigation.

To obtain even water distribution, it is necessary for the furrow to fill rapidly and add water at the rate at which it is absorbed by the soil.

Soil texture and slope determine the length of run. It is shorter on light soils and longer on heavy soils.

While furrow irrigating, give attention to maintaining the furrows and the amount of water applied. In general, 1 to 1 1/2 inches of water are needed per week from April through July supplied by irrigation, rainfall or both. Vines should not be stressed to wilting. Soils which are deep with high water-holding capacity usually require only three to five furrow irrigations per growing season.

5. Drip Irrigation

Most grape vineyards in Pakistan are ideally suited to drip irrigation.

Advantages of drip irrigation include the following points:

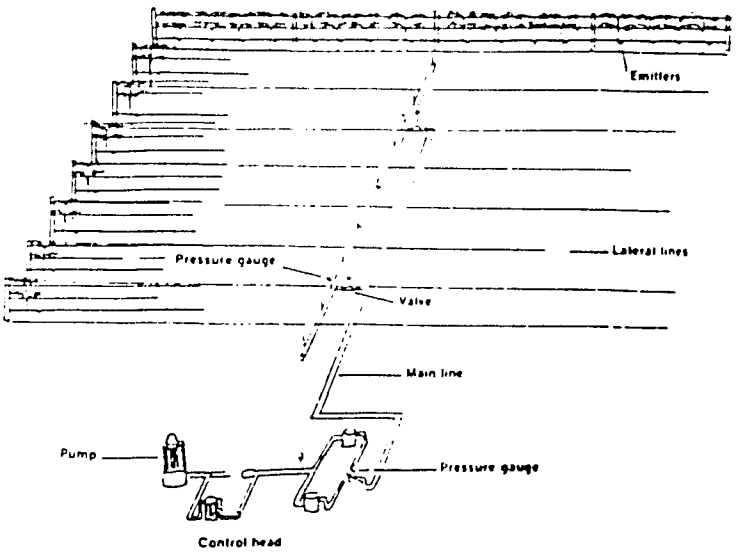
* Precise amounts of water can be delivered directly to each vine as needed.
* Water losses from evaporation, runoff and deep percolation are reduced.
* In young vineyards, water savings are particularly great.
* Weed growth is reduced between the rows.
* Localized wetting zone permits frequent cultural operations and reduces labor-scheduling problems.
* The system may be used for fertilizer application.
* Low flow rate permits irrigation on soils where permeability is a problem.
* Salts in soil remain more diluted.

Disadvantages consist of the following points:

* A disadvantage is the high initial cost of installation.
* It is difficult to control weeds around the emitter when on the ground.
* Foreign particles in the water may cause severe clogging problems.
* Rodents, coyotes, etc., sometimes damage the lines.

The water distribution pattern under drip irrigation is much different from those under the more conventional methods. Water is added at discrete points on the soil surface rather than over the entire area.

a. Components and Equipment. Components of a drip system can be grouped into three principal categories: (1) control head, (2) water distribution lines and (3) emitters. The actual layout and parts vary considerably from one vineyard to another, but they all have components of these three classes.



i. Control Head. This part of the system varies from one vineyard to another. A comprehensive system includes a pump, pressure gauge, water meter, filter and valves. Additional components such as a fertilizer tank and injector, manual or automatic time clock, pressure regulator, etc., are optional.

Filtration is a must for vineyards. Irrigation waters contain varying amounts of sand, clay particles, salts and algae. River, canal and pond water usually require more filtration than well water. Suspended materials may accumulate in the small orifices and reduce or stop the flow from the emitters. Common types of filters are sand filters, screen filters and centrifugal filters. The type of filter required depends

on water quality, ease of maintenance and emitter used.

ii. Main Lines. A system normally includes a main line which delivers water from the water source to the laterals, to which the emitters are connected.

iii. Lateral Lines. Laterals are usually 1/2-inch or smaller polyethylene (PE) pipes. Laterals are stretched along the vine-row. They can be hung on a low wire or laid on the surface. Hanging the lateral on a wire is very common as it enables cultivation and incorporation of herbicides. The lower trellis wire may also be used for this purpose. An outlet is needed at the end of the lateral to drain water for freeze protection and for flushing to clean out lines.

iv. Emitters. Emitters are devices that apply water in the form of drops to the soil surface. The typical operating pressure of the emitters is 10 to 20 pounds per square inch. There is a great variety of available emitters.

H. Fertilization

Grapes have traditionally required little or no fertilizer. However, if vine vigor is low, fertilization could be needed.

As grapevines mature and begin to produce heavy yields, at least some fertilization is necessary to maintain good vigor, quality grapes and regular crops.

In Pakistan during the first 2 years of vineyard establishment, nitrogen fertilizers are seldom needed except in deep sand where soil analysis shows a deficiency.

Fertilization replenishes the soil with nutrients used by the plant for fruit production. Compared to other fruit crops, the grapevine has a modest demand for fertilizers. Only 10 percent of the total nutrients taken up by the vine are removed in the fruit. The amount removed with pruned canes varied from one vineyard to another. Some of the minerals in the leaves, and sometimes the pruned canes, are returned to the soil.

The relatively small demand for fertilizer is a result of the grapevine's deep and strong root system. With extensive branching and possible penetration into the subsoil, vine roots survey great volumes of soil.

Often grapes are grown in shallow, marginal soils of low or high pH and of poor inherent fertility. Presently in Texas, nitrogen deficiency problems rarely occur. The general rule that all Texas soils should be improved with nitrogen does not apply for grapes.

Nitrogen (N) is the major element to be concerned with in Pakistan. Phosphorus (P) use by the crop is very small, or about 3 pounds per acre per year. Soils in Texas are usually rich in potassium (K) and do not require any amendment. Most Pakistanian vineyards are grown on neutral to basic soil with a pH of 6.7 to 8.1, hence problems of zinc (Zn) or iron (Fe) deficiency may occur.

1. Laboratory Analysis

Observation of a vine's outward appearance is not always sufficient to determine fertilization needs, as yields are affected before other symptoms show.

Laboratory analysis of soil, leaf and water samples from the vineyard is recommended annually to confirm visual judgment.

The laboratory analysis for grapes is performed on the leaf petiole. A good sample size per variety is 25 to 75 petioles per vineyard or per section of 10 acres or less. Collect the petioles at or near the peak of the bloom from the leaves opposite clusters. Separately sample areas of different soil types or where other major conditions may cause a different response of the vines.

An analysis may be run for the three major elements (N, P, K) and specific micronutrients such as Zn, Fe, and B. Results are then interpreted with a set of critical values for each element (table 1).

Table 1. Nutrient composition of grape petioles

Element	Petiole content (ppm)		
	Deficient	Normal	Excess
Nitrogen (NO^3-N)	350	600-1,200	2,000
Phosphorus (P)	1,500-2,000	3,000-6,000	--
Potassium (K)	10,000	10,000-12,000	30,000
Magnesium	3,000	5,000-8,000	10,000
Zinc	15	25-50	--
Boron*	25	40-60	300
Chloride	--	500-15,000	5,000

*Blade content

These values can only serve as a general guideline since actual levels may vary with variety and location. High vigor varieties may show only a moderate content of N. Therefore, visual observation of the vine should always be the primary criteria; use tissue analysis as verification.

2. Soil Analysis

A good soil test gives the grape grower an indication of fertilization needs and salinity problems. The key to good analysis is adequate sampling.

3. Nitrogen Requirements

Fertilizer application rates can therefore range from 0 to 30 pounds of actual N (nitrogen) per acre per year.

Sandy soils may require higher application rates. High vigor varieties require less nitrogen. Vineyards with sod in the middles generally require more nitrogen. Spot applications may be needed when only a few vines show deficiency symptoms.

Young vines in their first and second years seldom need fertilization.

a. Excess Symptoms. Leaves are lush and dark green. Shoots have long and flattened internodes. The most significant negative effect of overfertilization with N is late season vigor which may result in severe freeze injury. When excessive N is needed, flowers and berries shatter or fall off. Excessive N under drought conditions and shallow soils could cause marginal leaf burn.

b. Time of Application. The grapevine's greatest need for nitrogen is during early spring growth and through bloom. Therefore nitrogen should be available to roots as growth starts. A few days to 3 weeks are needed for most fertilizers to be converted to an available form.

The demand for nitrogen diminishes through mid and late summer. Totally avoid late season application. In very sandy soils where nitrate-N is susceptible to leaching, it is better to apply in two or three applications at 2- to 3-week intervals.

4. Iron

High pH in many Pakistan grape-growing soils causes minor element problems. Iron chlorosis is one of these.

This is very important the first 3 years of vineyard establishment. American and French-American hybrid varieties are prone to iron chlorosis more than vinifera varieties.

New growth shows iron chlorosis first. When the deficiency is severe, old leaves are chlo-

rotic. The network of veins remains green while leaves become pale green or yellow. In severe cases leaves become nearly white followed by dark brown leaf margins. Under severe iron chlorosis conditions, vines produce poor fruit.

a. Correction of Deficiency. Where iron chlorosis problems exist, soil treatment gives the best results. Iron chelates are most effective. Fe-EDDHA as Sequestrene 138 or Feriplex 138 is most effective on alkaline soils.

Foliar sprays only benefit existing leaves. Repeat sprays of iron chelates are required at 10- to 20-day intervals.

Apply chelate iron to the soil at a rate of 1 tablespoon per vine in May at the first sign of interveinal chlorosis. It can also be injected through the drip system at a rate of 1 pound of chelate per acre.

First, mix the 1 pound of chelate in 50 gallons of water and then inject it through the system to 1 acre.

5. Zinc

Mild deficiencies of zinc (Zn) have been encountered in Pakistan. Zn is usually present in the soil but may be in an unavailable form. Availability decreases with increasing pH, and deficiency problems may be expected in soils with pH greater than 7.0. Ceratin varieties and rootstocks are more susceptible to Zn deficiency than others.

a. Deficiency Symptoms. Visual symptoms begin to show on newly formed leaves in early summer. Leaves turn chlorotic and have a characteristic widened petiolar sinus or leaf indentation where the petiole is attached. Leaves are smaller than usual, and growth may be stunted. Fruit develop in straggly clusters. Most of these symptoms can be confused with other nutrient deficiencies or viral diseases. Therefore verify diagnosis with petiole analysis.

b. Correction of Deficiency. Foliar sprays of NZN or neutralized zinc sulfate can be used on vines. Apply NZN at a maximum rate of 1 pint per 100 gallons of water. It is essential to add at least 1/2 pound lime to every pound of $ZnSO_4$ to prevent foliage burn.

I. Cluster Thinning

Use cluster thinning to maintain vine health and improve grape quality. Thinning, along with pruning, reduces the grape crop to a level the vine should bear. Overloaded vines are weak and freeze susceptible. Also, grapes from overloaded vines ripen later, are more subject to decay and fail to develop good, uniform color and cluster size.

1. Thinning Versus Pruning

Since thinning is performed after clusters form, thinning improves quality more than pruning does. Crop level and vine capacity can be judged better when thinning than when pruning. Hence, thinning, along with proper pruning, allows one to grow as many grapes as the vine will bear without decreasing quality. In the long run, crop size may even increase because less severe pruning is required, allowing a greater leaf area to support the thinned crop. However, make sure that sufficient time and labor will be available to perform this task at the proper time. Use either flower thinning or cluster thinning to thin vines.

Flower and cluster thinning are generally practiced beginning the second and third years. Remove all clusters the second year to maximize shoot and root growth. Only one cluster per bud or shoot is left during the third year. In later years, crop load is generally controlled by pruning. However, if vines are weak, it may be best to thin. Also, vines that have a very heavy set require thinning to produce a high quality crop.

Flower thinning is performed between the time the shoots leaf out and fruit set occurs. The earlier this is done the greater the effect. By reducing the number of flower clusters without decreasing the number of leaves, there is more food available for the remaining berries. As a result, there is generally a better set of normal berries.

Flower thinning is usually used on varieties with loose clusters or which set many shot berries. Unless vines are very weak, never flower thin varieties that produce compact clusters, because it can cause clusters to become excessively compact. At the time of flower thinning there is very little foliage to hide the blooms, thus reducing the time required to complete the task. It can be completed in one-half to two-thirds the time required to cluster thin. However, this is offset by the difficulty of selecting the best potential clusters, and late developing clusters may be missed causing a heavier crop to set.

Cluster thinning removes entire fruit clusters after the crop has set. It is the easiest and most widely used method to reduce the crop on overloaded, high producing vines. It is used on varieties which set fruit well within the cluster but simply have too much fruit.

Essentially, cluster thinning is a grading and sorting of fruit clusters at a very early stage. Undersized, misshapen or oversized clusters can be removed.

J. Propagation

It is generally best to purchase vines from a nursery with a good, well-known reputation that handles healthy, vigorous and disease-free vines. The best vines are purchased from a nursery in a clean stock program.

It may become necessary, however, for a grower to produce some of his own vines if they cannot be obtained from a reliable nursery.

Before collecting wood for cuttings, visually inspect the vines during the summer before harvest. At that time either mark the desirable vines or undesirable vines so that only wood from good vines will be taken. Select only wood from vines that are growing normally and have an average crop of well-colored fruit and uniform berry and cluster size. Avoid vines with light crops, poorly colored fruit, a shot berry condition, straggly clusters, malformed leaves, abnormally colored leaves and stunted vines.

Cuttings are collected during the dormant season when vines are pruned. Basal cuttings are considered the best. Generally they are the largest in diameter, have the most stored food and usually have shorter internodes at the base. Such cuttings form the heaviest rootings. Also, canes that have been on top of the vine, exposed to the sun, and have well-matured wood with relatively short internodes are preferred to those located on the lower parts of the vine that are somewhat shaded and have longer internodes. Cut canes into cuttings 14 to 16 inches long with four or five nodes. The basal cut is made straight across through the bottom node or just below it. The upper cut is made 1 to 1 1/2 inches above the top node at a 45 degree angle. Thus, it is easy to tell the top from the bottom when the cuttings are planted.

Cuttings may be planted immediately in the nursery row, or they may be stored for a short time. If not planted immediately, label and bind the cuttings with soft wire into bundles of 50 or 100. Then store the cuttings in a well drained sand pit or trench. The pit is deep enough to permit the cuttings to be placed in an upside-down position and covered with a layer of sand 12 to 18 inches deep. The basal ends of the cuttings slowly callus in this manner. Callus forms first at the bases of the cuttings. Then the top buds begin to push. Roots do not appear at the base of the cuttings until the top buds are 1/2- to 1-inch long. The best time to plant cuttings is in April when there are roots at the bases of the cuttings and top buds are about 3/4- to 1-inch long.

Cuttings are normally planted in nursery rows 36 to 40 inches wide and 4 to 6 inches within the row, following the callusing period. Plant the cuttings with only the top two buds exposed. Then water the rows to settle the soil.

Cuttings develop during the summer and fall. In the winter they are dug with shovels, a U blade or a chisel shank on the back of a tractor. Cut the tops of the rootings back to a single shoot with only two buds. Then, cut off the roots at the top node and cut back other roots to 2-inch lengths. Plant only rootings which are healthy with vigorous root and shoot growth. It is extremely important that root systems do not dry out from the time of digging until planting.

K. Changing Varieties by T-Budding

In the life of a vineyard, it occasionally becomes necessary to change varieties because of poor performance, disease problems or a combination of both. T-budding is one of the most successful methods used to change varieties in Pakistan. Buds are generally placed just below the lower wire on a standard two- or three-wire trellis. This allows the original trunk to be retained so that herbicides and row plows can still be used.

Start T-budding in late April, when the bark is slipping well, and complete by June. This early cut-off date is necessary to get proper wood maturity to prevent freeze damage and winter kill.

Before budding, remove most of last year's brush. Leave several spurs on the old trunk so shoots can develop and cause the bark to slip. There may be 12 to 18 inches of shoot growth before the bark actually begins to slip.

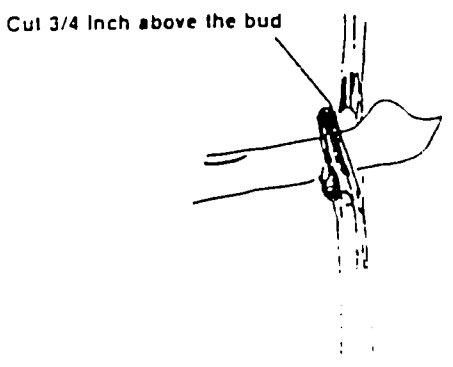
Preparing the Stock

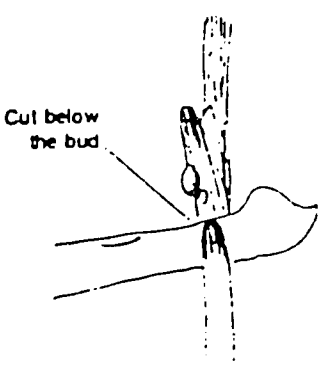
Cut the vine off about 12 to 14 inches below the lower wire. Remove all loose bark from the area where the bud is to be placed. Vine trunks are more oval than round so place the buds on those areas with the greatest curvature. Make a vertical cut 1 1/2 inches long 2 inches below the top. Make the second cut at a right angle crossing the top of the first cut, thus forming the "T". Then use the point of the knife to peel open both corners. The trunk is now ready for the bud to be inserted.

1. Bud Sticks

Now remove a bud from a 1/2 inch diameter bud stick that was collected in January, February or March when the desired variety was dormant. The bud sticks were wrapped in moist, not wet, paper towels, sealed in a polyethylene bag and refrigerated at approximately 30 to 36 degrees Fahrenheit, when they were collected.

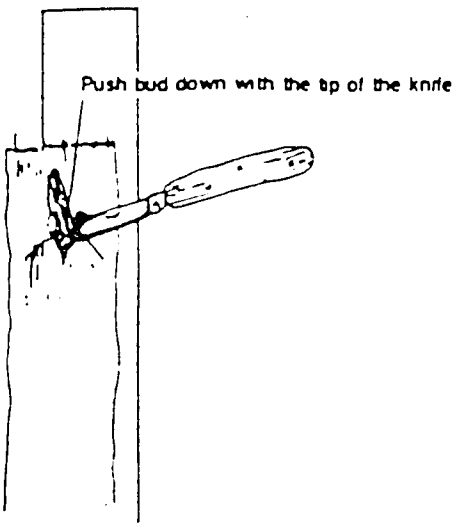
First make a cut angling downward into the stick from 3/4 to 1 inch above the bud to 3/4 to 1 inch below the bud. Make a second angled cut downward 1/2 to 3/4 inch below the bud to intersect with the first cut, severing the bud from the stick. These cuts are probably the hardest part of the entire procedure.





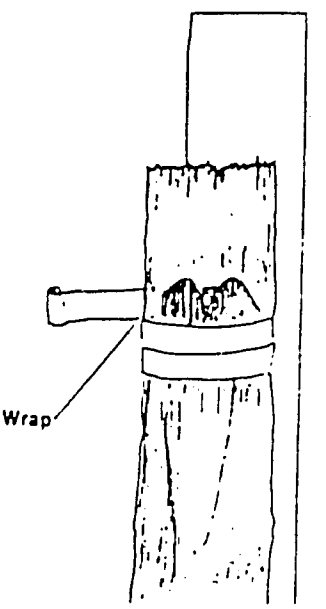
2. Inserting the Buds

Then insert the bud under the open corners of the bark and push the base of the bud shield well below the bottom of the vertical cut with the point of the knife blade. Generally two buds are inserted at the top of the trunk opposite each other.



3. Wrapping the Bud

Cover the bud with tightly pulled, overlapping wraps of white, 4-mil plastic flagging tape.



Start the first one or two wraps of tape at the top to catch the two loose flaps of bark. Then move down below the bud and start wrapping upward. One or two wraps may be just below the bud. Place the next wrap over the bud, centering the bud in the tape. Then wrap upwards, overlapping wraps to about 2 inches above the bud. Tuck

the last wrap under the next to the last wrap and pull it tightly. Then use the budding knife to carefully make a very small slit in the tape over the bud, being careful not to cut into the bud. The budder may also choose not to cover the bud eye with the tape. To prevent bleeding, make two slashes with a fine-toothed pruning saw on opposite sides of the trunk about 6 to 12 inches above the soil so that bleeding occurs at the cuts and not at the top of the trunk.

4. Care After Budding

A few weeks after budding, the bud pushes out 1/2 to 3/4 inch. Cut out the new growth above the bud or on the trunk. The bud will remain there for 4 to 6 weeks with no activity. Finally, the bud starts to push past the 1 inch length. After this happens, it grows very fast.

First one shoot develops, then, a week later, two or more shoots develop. As new shoots grow, tie them to wires to prevent breaking off.

These shoots form new cordons for fruiting the next year. Leave any fruit clusters which form the first year to slow down growth, help mature the wood and prevent freeze damage.

5. Inverted T-Budding

This method gives as good a take as regular T-budding. The main advantage of inverted T-buds is that there is less tendency for the top shield of the bud to pull away from the trunk. Wrapping is also faster.

With either method a 90 percent take is expected. This may be even higher when more experience is obtained. It is an easy method to learn quickly.

L. Varieties

The most important table grape varieties produced in the United States are summarized in table 2.

Table 2 Important California Grape Cultivars

CULTIVAR-a	COLOR-b	SEEDLESS	PRODUCTION (% OF TOTAL)
Thompson Seedless	W	Yes	39%
Flame Seedless	R	Yes	21%
Emperor	R	No	9%
Perlette	W	Yes	6%
Ruby Seedless	R	Yes	6%
Ribier	B	No	3%
Calmeria	W	No	3%
Exotic	B	No	2%
Redglobe	R	No	2%

Source: California Table Grape Commission.
a-Other important black cultivars include "Beauty Seedless," "Black Corinth," "Niabell"; red cultivars include "Queen," "Flame Tokay," "Christmas Rose," "Cardinal"; white cultivars include "Superior Seedless," "Italia,"and "Almeria.
"b-B, black, blue; R, red, pink; W, white, green, yellow.

Surveys have shown that consumers much prefer seedless grapes over those containing seeds. Therefore, production in Pakistan should concentrate only on seedless varieties. Four of the top choices: 'Thompson Seedless,' 'Flame Seedless,' 'Perlette,' and 'Ruby Seedless' are individually detailed later in this publication. A fifth variety, 'Superior Seedless,' is also a very good choice. This white grape variety has relatively large berries even when untreated with hormones (GA) or girdling.

M. Rootstocks

All vinfera vines need to be grafted on nematode and phylloxera resistant rootstocks. The standard rootstock in Pakistan has been Paulson 1103 (P1103). The 41B rootstock is also used in alkaline soils because of its lime tolerance. The SO4 rootstock has also been recently introduced into the country.

N. Seedless Table Grape Production Practices

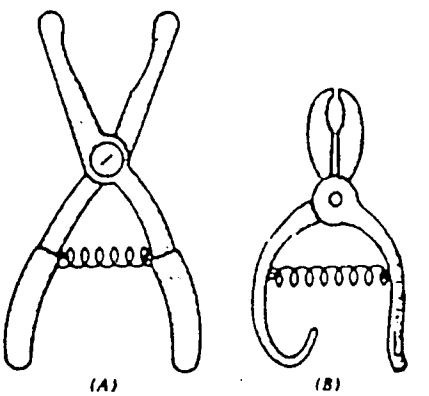
The use of special cultural practices is necessary for the production of quality table grapes. These practices include flower cluster and berry thinning, cluster rachis trimming, deleafing, girdling, and growth regulator application.

1. Girdling

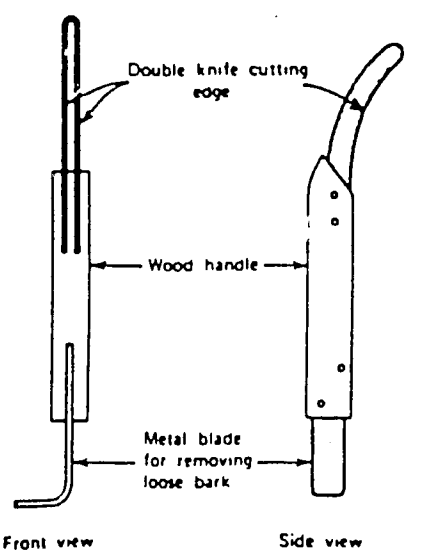
In woody plants there is a very important layer of cells called the vascular cambium. This vascular cambium, or cambium layer, may consist of one or a few cells in thickness but is responsible for all of the production of cells which cause woody plants to increase in diameter. As the years pass, the trunk and branches enlarge in circumference as cells are produced by the cambium. The cambium layer is situated between two types of cell structures known botanically as the xylem to the inside of the cambium and the phloem tissue to the outside of the cambium layer. The xylem is responsible for transporting water absorbed by the roots to the upper portions of the plant. The phloem tissue is important in the movement of sugars and amino acids, which act as the building blocks for starches, protein, and fats to areas of the plant where these are utilized or stored. In grapes these materials are produced in the leaves and are generally transported downward in the phloem tissue and laterally via vascular ray cells. Proper girdling causes a temporary disruption of this downward movement of foods without interfering with the upward movement of water. The end result is the production of larger berries.

Girdling is the removal of a strip of bark on either the trunk or canes. This strip of bark is known botanically as "phloem" and lies outside the cambium. On the trunk, this live tissue varies in thickness from a minimum of .55 mm to 1.5 mm (about 1/64" to 1/16") or slightly more, being the thickest on young vines and the thinnest on old vines. The thickness averages about 1.0 mm on moderately vigorous vines of moderate trunk diameters. This live tissue lies under several layers of dead loose bark, a layer of which accumulates annually and which is more or less persistent. Typically there are several years accumulation.

Girdling knives are manufactured in three widths, 1/8, 3/16, and 1/4 inch for trunk girdling knives, and in one width, 3/16 inch, for cane-girdling.



Cane girdling tools



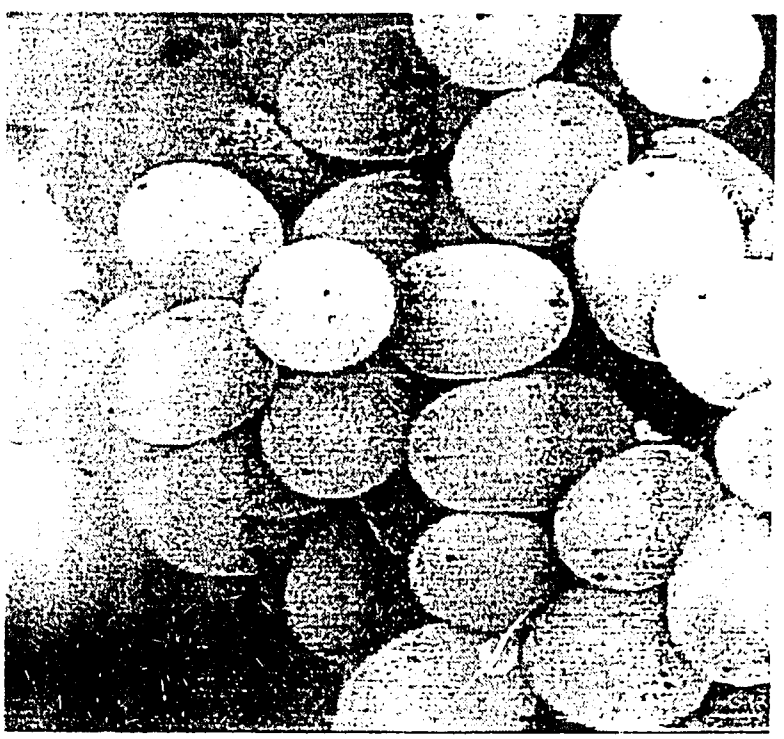
Trunk girdling knife

The 1/8 inch is generally only used for reopening girdles. Currently the 1/4 inch trunk girdler is the most common on Thompson Seedless for berry enlargement, and the 3/16 inch for maturity enhancement on such varieties as Cardinal, Ribier, etc. Experimental work shows that the

width doesn't matter so long as the girdle is complete, that is, all the phloem tissue is removed. All girdles, regardless of width, heal in about the same length of time.

A knife-line girdle, a cut through the phloem without removing any tissue, is usually not as effective as a 1/8" or wider girdle. Probably the phloem reunites rapidly. The knife-line girdle is sometimes used on young vines that must be girdled on the trunk.

a. Purpose of Girdling. Grapes are girdled either to increase berry size or to advance maturity. Most seedless varieties, if girdled at fruit set, without gibberellin, will increase in weight from 40 to 60% compared to those not girdled, depending upon how well the vines are thinned. With gibberellin treatment, berry weight will increase about 20% due to girdling treatment. Seeded grapes girdled at fruit set will show only modest increases in weight, usually in the range of 5-10% but occasionally up to 20%. Colored varieties, girdled at fruit set, may show some difficulties in color development. Girdling also reduces the amount of shatter in table Thompson Seedless. For some reason, girdling increases the strength of the attachment of the berry to the capstem.



Vines girdled at the beginning of the ripening phase (as indicated by the development of color or softening of the berries) will accumulate sugar more rapidly and also develop more color (if a colored variety). This permits harvesting up to a week or so earlier than on vines not girdled. The benefit is contingent on the vines not being overloaded with fruit. Should this be the case, no advantage may be gained.

Sometimes vines are double-girdled, that is, girdled at fruit set for berry weight increase, and again at the beginning of ripening to enhance maturity. This is believed to be rather hard on the vines. Only a few growers follow this practice on such a variety as Ribier. Even then, a grower will usually not double-girdle the same vines every year. When vines are double-girdled, the girdles are reopened in the same spot by removing the tissue in the healed-over girdle, frequently with a narrower knife than the first time. Thus, if the first girdle was made with a 3/16 inch knife, the second girdle will be made with a 1/8 inch knife.

The practice of girdling itself would seem to be weakening since the supply of nutrients to the roots is cut off for the period of healing. However, a great many vines have been girdled annually for a great many years (a few for 50 years) and there is no evidence that the vines cannot tolerate the practice if properly done and the vines well cared for.

Even if you have never girdled a vine, it is easy to tell how deep to girdle. Remove the loose bark from the trunk. Take a pocket knife and make two cuts into the live bark about 1/4 inch apart, say an inch in length. Cut across one end and pry up the bark. It will separate from the deeper wood at the cambial layer. This bark will be about 1.0 mm in thickness (roughly 1/32 inch). This is how deep the girdles must be made. As a practical matter, the girdles should go very slightly into the wood (botanically this is the xylem) but barely so. If the wood is cut too deeply, the vine can be injured because these tissues are the most active water conductive tissues. Additionally, the girdles may not heal over completely. The most commonly used system of checking girdles is to examine the girdles 20 minutes or more after they have been made. Phloem tissue will turn dark while girdles made deeply enough remain white. Of course the girdles could be too deep. You can check this by the appearance of the wood. Xylem is fibrous and therefore looks slightly rough. You can also check by cutting along side the girdle with a pocket knife to see when the bark slips, the natural separation between the phloem and xylem tissue. The above holds true for girdles made at fruit set. When girdles are made for advancing maturity, 4-8 weeks after fruit set depending upon the variety, there may be two layers where the bark will separate from the underlying tissues. This is due to cork cambium formation. The girdle must be cut to the deeper of

the two cambial layers. The thickness of bark removed is the same during the fruit set stage.

Trunk and girdling knives are manufactured and can be purchased from Malaga Maid Manufacturing, 2895 S. Chestnut Avenue, Fresno, California 93725, telephone (209) 266-8231. For further information write to P.O. Box 2855, Fresno, California 93745.

O. Plant Growth Regulators

1. Ethephon (trade named Ethrel [Registered])

In plants, there are many naturally occurring plant hormones which in very small quantities have a great deal of effect on the plant. One of these is ethylene gas. Ethylene gas is the hormone which triggers the ripening process in plants. This causes tomatoes to turn red, plums to develop their purple color and in grapes causes the berries to soften and begin to change color while developing sugars.

Ethephon (trade named Ethrel [Registered]), a product of Union Carbide, is a chemical which can be sprayed onto many grape varieties to enhance their ripening process. This non-toxic material is absorbed by the plant and releases ethylene gas within the fruit which enhances ripening. Many varieties such as Cardinal, Emperor, Flame Seedless, Ruby Seedless, Queen, Red Malaga and others develop a much richer and more uniform berry color when treated with ethephon at the beginning of the natural ripening period. For most varieties, ethephon is applied as a spray to the plant when the berries first begin to show a slight change in color.

On a commercial scale a farmer would typically be applying this material at a rate of one pint per acre of vines (typically 454 vines/acre) in 25-200 gallons of water. The home owner often has difficulty in converting this figure in order to treat his/her few vines. The easiest way to mix this material at home is to mix one gallon at a time. One gallon is enough solution to treat two grape vines. In other words apply one-half gallon of solution per vine.

To mix a solution of ethephon equivalent to one pint per acre simply put 47 drops of Ethrel [Registered], from an eye dropper, in one gallon of water and stir well. Do not put more Ethrel [Registered] in the mixture. Remember, growth regulators are extremely active in small quantities and adding more will cause injury to the plant.

2. Gibberellin/Gibberellic Acid (trade named Pro-Gibb [Registered] 4% Liquid or Gibrel [Registered])

In plants, there have been over 50 different forms of gibberellin that have been identified. Gibberellins are important in seed dormancy, cell enlargement, phototropism (the movement of plants toward the sunlight) and many other factors. In the commercial production of table grapes, the gibberellin which has been widely used is gibberellic acid number 3 usually referred to as GA3.

In varieties like Thompson Seedless, Flame Seedless, Perlette and a few other varieties (seedless grapes primarily), GA3 (gibberellic acid) is used for either thinning out the number of flowers which set fruit a bloom, or for increasing the size of the berries (referred to as a sizing spray which is applied about one week following bloom). In some varieties both a bloom spray and one or two sizing sprays are generally applied. Not all varieties respond to bloom sprays for thinning. These varieties may use a gibberellin spray only for increasing the size of the berry. Grapes which produce seeds are generally larger than seedless grapes because seeds produce natural gibberellins which increase the size of the berries.

One must be extremely careful when using GA3 on grapes. Each variety has a different tolerance level and one should not "experiment" or use more of the material than is recommended for any given variety.

The gibberellin produced for commercial use in grapes is manufactured by either Abbot Laboratories or Merk. It is produced in both a dry formulation and a liquid formulation. For most producers the 4% liquid formulation (containing 1.0 gram/fluid ounce of formulated product) is the easiest to use. Before applying gibberellin to your vines refer to the variety write-up for levels which each variety will tolerate. Do not exceed the recommended dosages. Higher than recommended levels can severely injure that plant.

The tolerance to levels of gibberellin increase as the season progresses. Bloom sprays are generally much lower than sizing sprays which are applied about one week later.

a. Gibberellic Acid Spray Guidelines. For all grapes, application is recommended by ground sprayer. Use 100 to 500 gallons as a dilute spray according to foliage density, or 30 to 80 gallons as a concentrate spray, unless specified otherwise. Do not exceed maximum rates. It is important to wet all berries thoroughly.

i. Thompson Seedless For cluster elongation ("Stretch"), looser cluster forms, and reducing cost of thinning, when used in conjunction with established girdling and thinning practices.

Guide: Apply 3 to 8.5 grams*/A before bloom when flower clusters are 3 to 5 inches long.

For decreased berry set ("Thinning"), reducing hand-thinning costs, and hastened maturity.
Guide: Apply 3 to 12 grams*/A during bloom. Higher amounts may cause an excess of shot berries or overthinning, except in high density plantings.
For larger berries ("Sizing") and larger clusters when used in conjunction with established girdling and thinning practices.
Guide: Apply 32 to 64 grams*/A when average berry size is 13/64" in diameter or as two applications of equal amounts with the first made at or 2 to 3 days after shatter, followed during the next two weeks by the second application. Timing of the second spray will be dictated by experience in the vineyard to be sprayed and temperatures occurring during the interim between sprays. Potential effect will be reduced if the second spray occurs more than two weeks after the first application.

ii. Thompson Seedless for Raisins. For decreasing berry set, with increased raisin quality, and hastened maturity.
Guide: Apply 0.75 to 6 grams*/A during bloom.

iii. Flame Seedless. For decreased berry set ("Thinning") and reducing hand-thinning costs.
Guide: Apply 3 to 7.5 grams*/A during bloom. Higher amounts may cause an excess of shot berries or overthinning.
For larger berries ("Sizing") and larger clusters when used in conjunction with established girdling and thinning practices.
Guide: Apply 8 to 48 grams*/A as one application when berry diameter reaches 6 to 8 millimeters, or as two applications of equal amounts with the first when berry diameter reaches 6 to 8 millimeters, followed during the next 5 to 10 days by the second application. Timing of the second spray will be dictated by experience in the vineyard to be sprayed and rate of berry growth during the interim between sprays.

iv. Other Seedless Varieties such as Perlette, Seedless Tokay, Interlocken Series and Related Hybrids.
For larger berries and larger clusters when used in conjunction with established girdling and thinning practices.
Guide: Apply 8 to 48 grams*/A as one application at, or just after, shatter (usually 2 to 3 days later) or as two applications of equal amounts not to exceed a total of 48 grams*/A, with the first made at or just after.
*Refers to actual Gibberellic Acid. See conversion Table to convert to amount of formulated Pro-Gibb needed.

CONVERSION TABLE

Grams of Actual Gibberellic Acid Per Acre	TO	Amount of Pro-Gibb (R) Formulation Per Acre
	PRO-GIBB	PRO-GIBB
0.5	2.5 grams	0.5 oz.
1.0	5 grams	1 oz.
2.0	10 grams	2 oz.
4.0	20 grams (1/8 bottle)	4 oz.
5.0	25 grams	5 oz.
8.0	40 grams (1/4 bottle)	8 oz.
10.0	50 grams	10 oz.
12.0	60 grams	12 oz.
16.0	80 grams (1/2 bottle)	16 oz.
20.0	100 grams	20 oz.
25.0	125 grams	25 oz.
32.0	160 grams (1 bottle)	32 oz.
40.0	200 grams	40 oz.
48.0	240 grams (1 1/2 bottles)	48 oz.
50.0	250 grams	50 oz.

*Refers to actual Gibberellic Acid

P. Harvesting

1. Proper Picking Time

Table grapes should be picked when they are attractive and have good eating quality, when they keep and carry well and, if possible, when they can reach the market and be sold for high prices. There may also be legal requirements regulating the proper picking conditions.

Ripening consists mainly of an increase in sugar, a decrease in acidity, and the development of characteristic color, texture, and flavor. These changes occur only as long as the grapes remain on the vine, and practically cease after picking. At veraison (the stage when berries begin to soften and color), the ripening rate increases sharply. Generally, there is a gradual improvement in quality until the optimum stage is reached for the intended use of the grapes; afterward, gradual deterioration occurs.

The acid and sugar content are the best measurements of maturity, and occasionally color estimates or measurements are also useful.

a. Sugar Test. The sugar content of ripe grapes can be measured with a hydrometer or a refractometer. These instruments are generally calibrated in the Balling or Brix scale and read directly in percent sugar by weight. The hydrometer measures specific gravity, the weight per unit volume as compared with that of pure water. Since sugar is the chief substance affecting specific gravity in ripe grapes, one may estimate the quantity of sugar present by measuring the specific gravity.

To make the test, take a representative sample of berries picked from clusters at random from various vines, mash the grapes, and express the juice from the pulp. The extracted juice is poured into a cylinder filled to overflowing, and the hydrometer is lowered into the juice until it comes to rest. The temperature of the juice is taken, and the temperature of calibration shown on the hydrometer is used in measuring the result to obtain the approximate percentage of sugar.

A refractometer will also give results in percent of sugar weight and is a more convenient, faster method. The refractive index of a sucrose solution is an accurate measure of the concentration of dissolved substance. One can squeeze juice from a berry onto the glass prism of the refractometer and make a reading. For a more representative reading it is best to get a reading on the extracted juice of 100-150 randomly sampled berries. Using a food blender is an effective and convenient method for juice extraction. Field readings should be taken with a temperature-compensating refractometer or one with a built-in thermometer for temperature correction of readings. Otherwise readings should be taken indoors at room temperature to minimize temperature variations.

b. Acid Titration. To measure acid, pipette 10 ml of clear juice into a small flask, then add 50-100 ml distilled water and 2 or 3 drops of phenolphthalein indicator solution. A standard solution of sodium hydroxide (0.133N) is slowly run from a burette into the flask containing the diluted juice, with a constant stirring of the flask, until the color turns pink. A solution standardized to 0.133 N is equivalent to 0.01 g tartaric acid per ml. The millimeters of sodium hydroxide solution used divided by 10 equals the tartaric acid in the juice in g/100 ml.

c. Degree Brix Acid Ratio. The degree Brix divided by the acidity in grams per 100 ml gives the Brix acid ratio (often referred to as sugar-acid ratio). This is a better measurement of palatability than sugar content or acidity used alone. The minimum desirable Brix acid ratio varies with different varieties: The ratio for Thompson Seedless, Malaga, and Ribier should be about 25:1, the Ohanez, Cornichon, Muscat, and Emperor 30:1, and the Tokay, Olivette blanche, and Red Malaga 35:1. In addition, most other varieties should have a Brix of 17 or higher. Ribier, Red Malaga, and Emperor should be at least 16 Brix. In practice, a lower minimum soluble solids was allowed for a variety such as Thompson Seedless, if it was produced in a hot district such as the Coachella Valley compared to that required for fruit from the cooler San Joaquin Valley. The argument being that the higher ripening temperatures depress the acid content

more than the cooler temperatures. The result is that the Brix/acid ratio may be the same for the fruit from each valley even though the degrees Brix may differ by one. The net effect is that both lots taste the same because the taste response correlates more closely with the Brix/acid ratio than with degree Brix alone. For example, the present minimum standard for Perlette grapes grown in California is 15.5 degrees Brix. If the acid content is low enough to give a 20:1 Brix-acid ratio, however, the fruit can be shipped at 14 degrees Brix.

The soluble solids content of the berries in a cluster of California table grapes can typically vary as much as 56 degrees B for fruit harvested early in the season, and the total acid content of some berries could be nearly twice that of others.

Climatic conditions affect the Brix acid ratio. If ripening occurs during hot weather, the ratio will be high and the grapes palatable at relatively low sugar; in cool weather the acid will be higher, and more sugar will be necessary for equal tastiness.

d. Estimating Maturation. By the use of several criteria one can judge when a cluster is ripe for picking. If the peduncle is brown and woody, or if the stem framework of the cluster is of light straw or yellow color, the grapes are probably mature. Although tasting the berries can indicate if the cluster is ripe, the sense of taste is quickly dulled by frequent use, so the picker must rely principally on other characteristics such as the fruit color or the condition of the stems. Often the vineyardist may correlate these visual criteria with the results of Brix-acid measurements to provide a suitable guide for pickers. Red or black grapes develop their characteristic color as they ripen; the best colored grapes are usually the ripest. Green or white varieties become more nearly yellow or white as they ripen.

Since all clusters do not ripen at the same time, even those on the same vine, picking is often done twice

or more to harvest the grapes at the proper stage.

2. Criteria of Quality

Clusters should be well developed, well filled, and have fresh, straweolored or yellow cluster stems and cap stems. The berries should be firm, plump, and have the typical shape and uniform color for the cultivar. Clusters should be free of sunburned or shot berries and berries scarred by thrips, powdery mildew, or wind damage. Firm berry attachment to the cap stems is also important. The berries should not be shriveled, crushed, or decayed. Undesirable aging is shown by brown, dry stems, shriveled and dull berries, and visible mold on stems or berries.

3. Packing

Table fruit is all hand-picked. In harvesting and packing, fruit is moved as rapidly as possible from the vines to coolers in refrigerator cars or cold storage. Some grapes are packed in the field, and others are house-packed after they are brought in from the field.

a. Field Packing. The picker should hold the cluster by the stem to remove it from the vine. The stem should then be cut with picking shears or a sharp knife. All defective berries, particularly those broken or decayed, should be carefully removed by clipping with shears the stem that attaches the berries to the cluster.

Berries should not be pulled off with the finger, leaving the wet brush attached to the cluster, as this will give fungi and other microorganisms a medium on which to begin growth. The cluster can sometimes be improved by removing the undersized or insufficiently colored berries. Often however, such clusters are better packed in a separate, lower

quality pack. Crushing grapes or breaking them loose from the stems should be avoided because any break in the skin permits easy entrance for molds, yeasts, and other decay-causing organisms.

Table grapes in lugs are usually packed by the "stems up" method. To make this pack, the box can be tilted by placing it crosswise in another box or on a special stand. Lay one or more clusters horizontally in the lower end of the box, and continue to fill the box from this end, with all clusters placed nearly upright except those needed to make the bottom of the pack solid. Occasionally press the fruit toward the low end of the box so that a firm pack is made.

b. House Packing. Grapes are picked into shallow boxes and carried to packing houses or sheds where clusters are trimmed, and carefully packed into standard size boxes of wood, corrugated board, or plastic. The movement of full and empty boxes and of the cull fruit is usually mechanized with conveyors, belts, and forklifts. Sometimes grapes are vibrated into position in the shipping container, and this may prevent much shattering of berries. Cushion pads at the tops and bottoms of boxes help prevent bruising of fruit. The bottom pad must also be absorptive to prevent fruit "wetting" from juice released from damaged berries. Other variations from the standard hand-place packs include the South African cluster-wrap pack and the sawdust export chest pack.

Q. Thompson Seedless

1. Description

Medium to long, seedless, white berry, ripens mid August to September, most popular table grape and raisin variety.

THOMPSON SEEDLESS

2. Training and Pruning

Head train and cane prune leaving four to six canes 10-14 buds long. Two to four bud renewal spurs are left in addition to the canes.

3. Flower Cluster Thinning

As a general rule, no more than eight clusters per cane, or 25-30 flower clusters per vine, are retained for table Thompson Seedless production. On the Thompson Seedless variety it is difficult to determine large, good quality clusters until after bloom and fruit set. Most of the cluster thinning should be delayed until early June following berry set and cluster elongation. At this time the poor quality clusters can be removed.

4. Gibberellic Acid Sprays for Thinning and Berry Sizing

Table Thompson Seedless should receive a bloom thinning spray of 10-15 ppm gibberellic acid when the clusters express 40-80% bloom. Full bloom is typically referred to when 50% of the clusters on the vine are showing 50-70% of the flowers in bloom. A spray of gibberellic acid directed toward the cluster area reduces the number of flowers that set fruit. This results in a cluster with fewer, but larger, diameter berries.

Following bloom, the clusters will go through what is called the berry set stage. This usually occurs 10-14 days following bloom and is the period when the unfertilized ovaries are aborted and fall to the ground, leaving only the fertilized ovaries to develop into berries. When these developing berries reach a diameter of about 3/16" (4-5mm), or the size of a wooden kitchen match head, the first sizing spray of gibberellic acid is applied. The

sizing sprays cause the cells of the berry to enlarge. This first sizing spray is generally 40 ppm and may be followed by a second sizing spray of the same concentration five to seven days later.

5. Girdling to Increase Berry Size

Girdling of the trunk or individual canes causes the fruit to increase in diameter. Girdles should be made following the berry set stage which is usually 10-14 days following bloom. This coincides with the first sizing spray, and both can be done on the same day provided the berry size is around the 3/16" diameter.

6. Cluster and Berry Thinning

By early June the clusters have fully lengthened and good quality clusters are easily recognized. At this time the poor clusters are removed to allow only 25-30 clusters per vine. This is also the time when the remaining clusters are shortened by cutting the cluster rachis so that only four to eight of the uppermost branches remain to develop fruit. The lower portion of the cluster is discarded. The number of branches retained on each cluster will vary depending upon the length of the branches. Clusters with very long branches may have only four retained, while smaller clusters may require six to eight branches to develop into a full size bunch at harvest time.

R. Flame Seedless

1. Description

Medium-sized, red, seedless berry, firm, crisp and flavorful, ripens in late July.

FLAME SEEDLESS

2. Training and Pruning

Train to a bilateral cordon. Prune to 12-16 two-bud spurs.

3. Shoot Thinning

When shoots reach six to eight inches, thin to two shoots per spur. Remove all shoots which develop from latent buds along the cordon and on the trunk.

4. Flower Cluster Thinning

When shoots reach 15-20 inches, flower cluster thin to one cluster per shoot. Generally, the best shaped cluster is retained. When more than one cluster is retained, the berries will be smaller in size and color development may be delayed. Side shoots and base leaves around the clusters do not need to be removed; however, tendrils are removed from the clusters at this time.

5. Gibberellic Acid Sprays at Bloom Time and for Berry Sizing

To decrease set, and to increase the size of the berries, gibberellic acid sprays may be applied. The first of these sprays is applied when 50% of the clusters on the vine show that bloom has begun on 50-70% of the flowers. At this time a gibberellic acid spray of 5 to 10 ppm will reduce berry set. This will result in slightly larger berries on the cluster. Rates higher than 10 ppm at bloom time may result in the production of small shoot berries. To further increase berry size, one or two additional "sizing sprays" of gibberellic acid may be applied. The first sizing spray is applied following bloom when the average berry size is about 1/4" (5-7 mm) in diameter. At this time, apply the first sizing spray at a rate of 20-30 ppm. A second sizing spray of 20-30 ppm of gibberellic acid may be applied approximately one week later. If a single sizing spray is to be used rather than two sizing sprays, the rate should be increased to 40 ppm and this should be applied when the berry size reaches 1/4" in diameter. Double sprays may produce better berry uniformity.

6. Girdling to Increase Berry Size

The largest berries are produced when gibberellin sprays are combined with a "size girdle." The vines may be girdled during the same period when the first sizing spray of gibberellic acid is applied. This girdle will stress the vines somewhat and adjustment of the crop load (leave fewer clusters if you intend to girdle - No more than one cluster per shoot) may be necessary. "Size girdling" also delays the color development and maturity of the fruit which may not be important when the fruit is grown for home consumption.

7. Berry Thinning

When the branches of the cluster have separated and are easily distinguished, which is usually about the berry set stage (when girdling is performed), the clusters should be reduced in length. Generally, the cluster rachis is cut with clippers to remove the lower 1/3 to 1/2 of the cluster. Usually only six to ten of the cluster branches are retained to develop berries. This thinning will give a full and rounded cluster of excellent quality at maturity.

8. Color Enhancement

Size girdling delays color development and maturity; consequently, growers of Flame Seedless may prefer not to "size girdle" but rather to rely on the gibberellin sizing sprays to increase the size and then to apply a "maturity girdle", which is applied just before color develops. By applying a "maturity girdle" when the berries change from a deep green to a translucent green (just before the red color begins to show) the fruit will turn color more quickly and maturity will be increased.

If even greater color uniformity and richness is desired, a growth regulator called ethephon (Ethrel [Registered] is the trade name - distributed by Union Carbide) can be sprayed onto the vines. This growth regulator is applied at the same time as the maturity girdle and will produce darker but softer fruit. The rate of ethephon is one pint per acre (generally applied to 454 vines). When reducing this to a per vine rate, one would use approximately 47 drops in one gallon of water. This would be enough to treat two vines.

Most growers will not choose to apply gibberellin or ethephon sprays or to girdle the vines. The above procedures produce optimum quality fruit of large size and good color. The natural fruit will be small but delightful.

Flame seedless can be dried into raisins which will be dark black in color. Birds also love this variety and may inflict serious damage.

S. Ruby Seedless

1. Description

Medium to large elongated berries, red to purple color, seedless, very susceptible to powdery mildew and bunch rot, ripens mid to late August.

2. Training and Pruning

Train to a bilateral cordon. Prune to 12-16 one or two-bud spurs.

3. Shoot Thinning

When shoots reach 8-14 inches, thin to one or two shoots per spur. Remove all unwanted shoots along the cordon and trunk of the vine. In addition, the basal leaves and lateral shoots are sometimes removed at this time up to and opposite the second cluster on the shoot.

RUBY SEEDLESS

4. Berry Thinning

Following bloom and the berry set stage, Ruby Seedless clusters should be thinned to reduce their size and potential for developing bunch rot. Rudy Seedless develops a large cluster and removal of the lower 1/2 of the cluster is not uncommon. If the entire cluster is retained, alternate branches should be removed along the cluster rachis to reduce the compactness of the cluster. An alternative is to cut the cluster rachis so only six to eight branches remain.

5. Fruit Exposure

Improvement in color development can be achieved by pulling off leaves around the clusters to give them better light exposure. The late season deleafing to expose clusters is generally preferred to the early heavy deleafing at shoot thinning time. Leaves should be removed around the cluster three to four weeks prior to harvest.

6. Special Considerations

This variety is especially susceptible to powdery mildew, and if not controlled the berries will crack and bunch rot becomes severe. Careful and frequent sulfur dustings to prevent mildew are absolutely required to develop good quality fruit.

7. Ethephon

Color development around the cap stem and at the flower end of the berry is often delayed in Ruby Seedless. An application of 1/2 to 1 pint per acre of ethephon, applied at first color development, generally overcomes this problem. One drawback is that some clusters may become exces-

sively dark in color. For home use, mix 23 drops of ethephon in one gallon of water to equal the 1/2 pint per acre rate. One gallon of this solution is enough to treat two grapevines.

T. Perlette

1. Description

Medium-sized, white, round berries, seedless, very compact clusters, may rot severely if not thinned, ripens in mid-July.

PERLETTE

2. Training and Pruning

Train to a bilateral cordon. Prune to 12-16 two bud spurs.

3. Shoot Thinning

Removal of unwanted shoots along the cordon is performed when the shoots reach 15-20 inches long. Shoot thinning when shoots are shorter may result in additional growth from latent buds.

4. Pre-Bloom Flower Thinning and Cluster Tipping

Perlette produces very tight clusters which can rot severely if not heavily thinned. Unlike many other varieties of grape, the Perlette does not respond well to bloom time sprays of gibberellic acid to thin out the number of flowers on the cluster. In order to thin this variety, two methods have proven successful. One technique is to "finger thin" each cluster branch by hand. This was the most widely used commercial technique until the late 1970's. The thinning procedure requires that at least 50% of the flowers on each branch of the cluster be pulled off just prior to bloom. For best results one should remove 70-75% of the flowers on each cluster, beginning about ten days before bloom. The flower removal should be completed by the beginning of bloom. This process may take 20-30 minutes per vine. Once the flowers have been removed, the cluster rachis is "tipped" (break off the cluster rachis with your fingers) so only the top six to ten branches remain. The lower portion of the cluster is discarded. The remaining portion of the cluster will produce full clusters with larger berries.

The second method of thinning is "brush thinning." A plastic scalp brush (known as the Solo Beauty Brush) is used to remove 70-75% of the flowers on each cluster. This brush is not readily available and finger thinning works well provided one removes enough of the flowers.

5. Gibberellin Sprays and Girdling to Increase Berry Size

To increase the size of berries, one may spray gibberellic acid at a concentration of 30 ppm to 40 ppm following bloom when the berries reach 3/16 inch in diameter. The vines should be girdled at this same time, which will further enlarge the fruit.

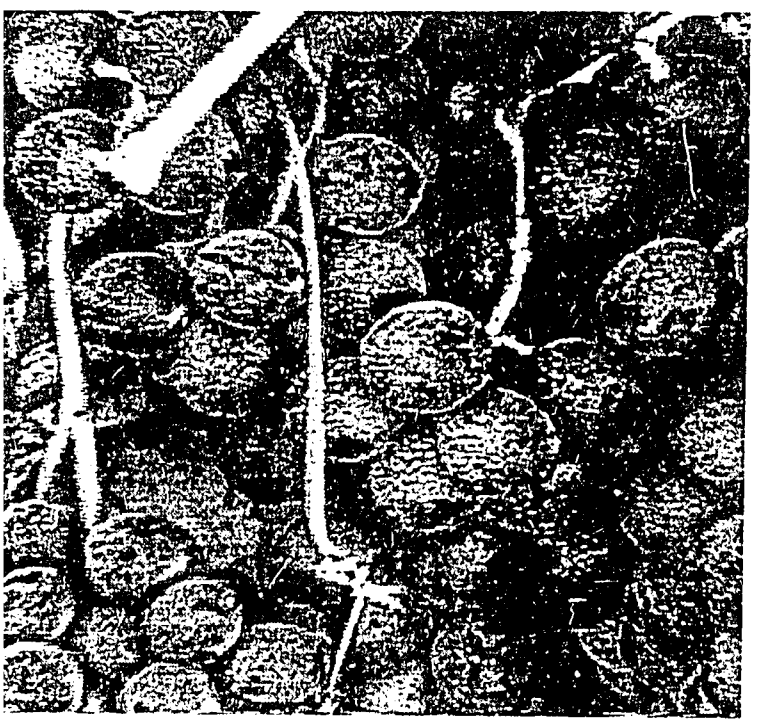
Grapes: Part II Harvesting and Handling

M. Joseph Ahrens Ph.D.

In order to know how to best harvest and handle grapes for the fresh market, it is very important to have an understanding of their structure and physiology during growth and development. The grapes are, of course, a living organism and respond to changes and influences in the environment which include handling, temperature, humidity, pathogens, and air quality and composition. How they respond is a direct result of the structure (morphology) and internal chemistry (physiology) of this plant part.

U. Structure

The grape is a fruit, which is borne in clusters of 100 to several hundred individual berries. Each berry at maturity is between 1 to 3 cm in diameter. The berries are held together with a branched stem.



This stem is very important to the postharvest life of the berry. It can dry, become brittle, and break. The berries might separate from the bunch (shatter). Not only is this usually unacceptable to the consumer, it also makes the berries more difficult to handle and can result in loss of the product. In some cases the stem can be the source of decay origination. The color of this stem is very important to consumers. Even though the edible berries might be in excellent shape, if the inedible stem is discolored or perceived to not be healthy, the grapes may be rejected or receive a lower price. Inside the berry, there may be 2 to 4 seeds of about 2-3 mm in diameter. These seeds are edible, and some consumers readily eat them; however, they are slightly bitter and fibrous. There are seedless varieties of grapes. It is important to understand which type the market desires. Surrounding the seed area is a watery pulp area of thin walled cells. This is where the majority of sugar is stored in grapes. Surrounding the pulp is a relatively tough thin (less than one mm) skin. The skin can be broken by mechanical force and does not offer much resistance to chewing. Most consumers eat the berries without peeling. The peel has a waxy coating and resists water loss. Water loss not only results in unacceptable flabby, soft berries, but causes an unappealing dull look.

V. Development and Maturation

After "fruit set" (fertilization and initial expansion of the ovary), the young immature berries go through a series of internal changes. Tissues form and develop. Vitamins, proteins, sugars, fiber, minerals, and other components are produced and stored. The fruit enlarges. The seeds mature and become viable (they will grow if planted). The pulp expands and the peel becomes relatively thinner.

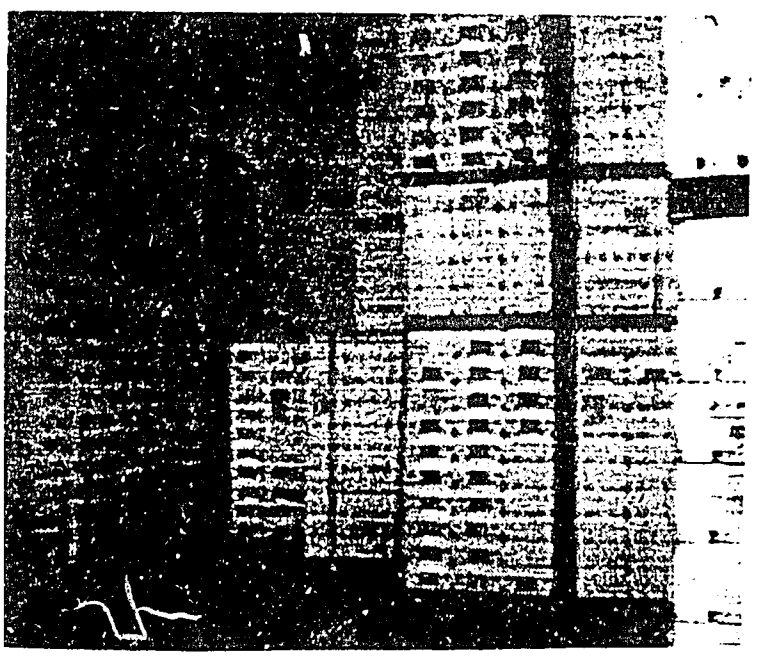
Color is the primary standard of appearance, especially in red and black grapes. In some countries, for instance, grades specify that each bunch must be up to 75% characteristic color for the variety as well for each berry shou at least 2/3 colored characteristically. As the berry matures, color develops (deepens).

Unlike some fruits, grapes do not continue to ripen after they are harvested. They contain very little starch to convert to sugar, so they do not become sweeter. Therefore, the amount or percent sugar is closely related to the maturity. For practical purposes the degree sugar is considered the same as the total soluble solids (TSS) and is measured on a degrees-Brix scale. The minimum degrees-Brix necessary to be considered mature varies with variety. Receivers may also specify the desired degrees-Brix they will accept. In order to sample the crop for maturity, clusters should be chosen randomly from the vines. Three to six

berries can be taken from the middle area of each cluster. The berries should be squeezed between the thumb and forefinger until 2-3 drops are produced. This is 9 to 12 total drops. The juice should be dripped onto the glass of a hand refractometer. The instrument should be rinsed well between samples.

The more mature a cluster, the more woody the stems are. The more immature, the more flexible, succulent, and green they appear. The more mature stems are tougher and break less easily. However, woody and tougher should not be confused with dry and brittle.

Just like almost all living organisms, grapes take up oxygen, use carbohydrate (sugars) for fuel, and give off carbon dioxide, water vapor, and heat in the process. Actually, very little sugars are converted into carbon dioxide and water, compared to other fruits. There is also little else happening internally. Therefore, under ideal conditions, grapes can be stored or shipped successfully for long periods of time (up to 6 months).



The most severe problems faced are water loss and decay. By keeping the berries as cold as possible without freezing, successful marketing is easily possible. However, grapes should also have a supply of ventilated air. Even though the grapes respire (breathe) at a low rate, they do consume oxygen and produce carbon dioxide. Over a period of time, without adequate ventilation, high levels of carbon dioxide can build up. Levels over 10% can injure them by turning the pulp brown. The continued demand for oxygen means that a minimum level must be constantly supplied or the fruit could shift into "anaerobic" respiration (breathing without oxygen) or "alcoholic fermentation". This results in off flavors and odors, which are unacceptable to consumers. Again, ventilating the storage room (or truck trailer) solves this problem. Usually, normal traffic through storage rooms with doors opening and closing is adequate to supply fresh air. The trailers or marine containers can be set for a specific fresh air exchange, such as 25 cubic feet per minute minimum.

The heat produced during this process of respiration is called "heat of respiration" or "vital heat", and can be very important in postharvest handling. The grapes must be kept cool and this heat constantly removed. If not, the fruit could warm up, decay, lose water and become soft. Water vapor produced can collect on packages and the surface of the grapes, weakening packaging material and further increasing chances of decay.

W. Factors Affecting Deterioration

There are many factors that influence the deterioration and ultimate quality of the product when it reaches the consumer. After becoming ripe, the fruit ultimately softens and becomes more susceptible to many types of injuries and decays. After harvest, water loss increases and the fruit is under increased stress. The high internal sugars provide an excellent environment, inviting many pathogens to invade and rot the grapes. We need to select an overall handling system that will minimize the deterioration and maximize the quality and shelflife.

1. Field Conditions.

Certainly, the general condition of the plant and its fruit upon harvest affects storage life. The healthier a fruit is when harvested, the longer it will last during its postharvest life. Excessive decay in the field will translate into weakened fruit and excessive decay during marketing. If the fruit vines are trellised and trained, more usable, good looking bunches can be produced. This is because the clusters hang free and are not subject to damage against the vines and leaves, and they are allowed to expand without distortion. Also, this helps the leaves to spread out and convert more sunlight into sugar for the fruit. The fruit is also shaded this way (protected by the overhead canopy of leaves) and do not get sunburned.

2. Temperature Effects.

Temperature is the single most important factor effecting the postharvest life of the grape. Lower temperatures slow respiration, deterioration and retard decay.

3. Mechanical Injury.

Grapes are subject to a number of injuries caused by rough or improper handling. Some are obvious and others are not. Shatter is the most common result of mechanical injury. Dry shatter is when the stems have cleanly separated from the berries. This is common in older bunches with dried out, weaker stems. Also, as the bunches develop, the berries naturally separate from the stems. Mechanical injury (shaking, vibration, dropping) magnifies this occurrence. Wet shatter is when the berries have been pulled from the stems and there remains a wet piece of tissue attached to the end of the stems where the berries were. This is less common than dry shatter and is the more common type of shatter in younger berries. It results from severe "yanking" of the berries and not from vibration or most shaking. Compression bruising occurs when the fruit are packed too tightly in a container, or are stacked too high on top of each other with inadequate or over-filled packages. This injury usually shows as flattened areas on the surface of the berries, which later turn brown. Excessive compression can split the fruit open. Impact bruising comes from fruit being dropped, either bunches, or whole boxes. Evidence of this injury is a flattened area on the surface accompanied with a water soaked area. Excessive impact can cause splitting of the fruit also. Shatter may be a symptom. It is often impossible to distinguish impact damage from compression damage. Other evidence must be observed, such as condition of the package and location of damaged fruit within the package.

X. Decay

Several pathogens will attack grapes and cause rots and surface injuries. Also, all of the proceeding factors affecting deterioration can also be linked to causes of increased decay. As the fruit is weakened, or is wounded and exposed to decay organisms (pathogens), rots increase. The following are important diseases of grapes.

1. Botrytis rot.

This is the most important rot of grapes. It readily invades wounds, but it can also directly penetrate the skin of healthy grapes. It grows vigorously at ambient temperatures (10° to 25°C), so is often present in the field. It will continue to grow in storage if it is on the grapes, but only very slowly at the recommended storage temperature of 0°C. The infection begins often when the grapes are wet, although sometimes it can happen without wet conditions. Do not harvest or pack wet grapes. If they have been wetted by rains or damp conditions, let them dry out on the vine for 2-3 days first. Sulfur dioxide fumigation of harvested grapes can stop further growth and spread of botrytis. For very long term storage, weekly fumigations may be necessary. If the field load of the pathogen is low, cold temperature alone may be sufficient for short storage or transit times (less than a month). In storage, botrytis causes the skins to separate from the pulp, characteristic of early stages of infection. If slight pressure is put on the berries, the skins can be caused to slip off, leaving the pulp intact. Eventually, the fungus grows onto the surface of the berries, covering them with a thin, powdery gray growth. At this point, botrytis is referred to as gray mold rot.

2. Cladiosporium rot.

This is characterized by small black spots that enlarge. After the very dark gray spots cover about half the berry, the area becomes white, then progresses to light green. The lesion becomes slightly firm and can be separated from the healthy tissue. It occurs mostly after wet rains and grows very slowly near 0°C. This rot is not detectable at harvest. Grapes should be monitored weekly in storage. Weekly sulfur dioxide fumigations can prevent its spread. Alternaria and Stemphylium can also cause a black spot rot, but can only enter the fruit through wounds. Wet conditions also encourage growth. However, if the pathogens are present, rough handling allows the invasion.

3. Penicillium rot.

This blue mold can infect grapes, but it is rarely a problem. It enters only through wounds caused by rough handling and infected equipment (containers, lugs, boxes). The pulp tissue is reduced to a watery mass.

4. Aspergillus and Rhizopus rots.

These rots only grow during hot weather. If they are present in postharvest grapes, it is because grapes obviously infected with the rots in the field have not been eliminated before packing, or else there has been severe temperature mismanagement in storage or shipping. Aspergillus is sooty in appearance. Rhizopus looks like it has been sprinkled with ground black pepper.

Y. Field Handling

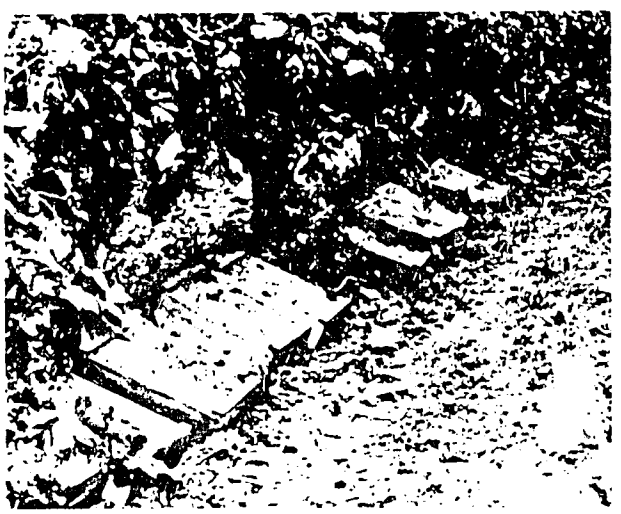
Grapes can be harvested and packed in the field or harvested and brought to a packinghouse for packing. There are benefits and disadvantages to both systems. Packing in the field means less overall handling, lower field bin inventory, better coordination of crews, and lower capital costs.

Bringing to a packinghouse means usually better control over sorting, grading, and packing, and it is easier to pack more than one grade or use different containers for different customers.

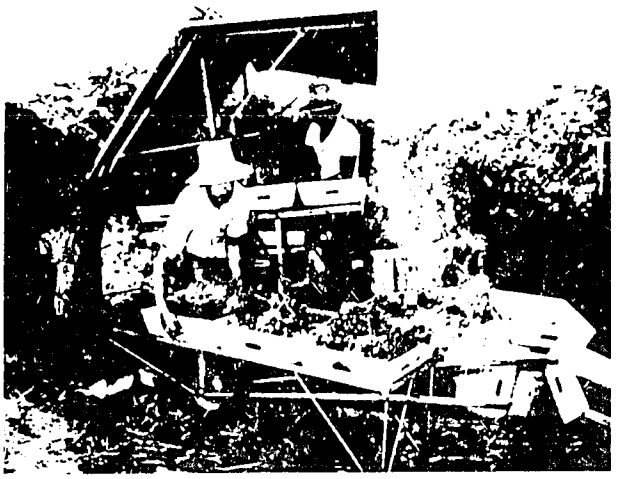
1. Harvesting.

Trash and debris should have been removed from the fields prior to harvest. Fruit and vines should not be excessively dusty. Vines should have been trimmed so that field equipment can easily move into the rows. Only harvest fruit that can be utilized, and for which you know you have a market. Do not pack or bring rotten fruit into the packinghouse. Do not pick or pack wet fruit.

For field packing, two systems are used. Individual harvesters can select a bunch off the vine, trim it to the desired size and shape, and pack the bunch directly into the shipping container.



Supervision is difficult. Maintaining similar quality between workers and lugs (boxes) can be difficult. However, experienced workers can do an excellent job with minimum handling and the least amount of mechanical injury. Another option is for a centralized, or several centralized, packing stations in the field. Harvesters select, pick and trim bunches from the vine and place into a lightweight tray. After several trays are filled, they are stacked on a small cart and taken to the packing station.



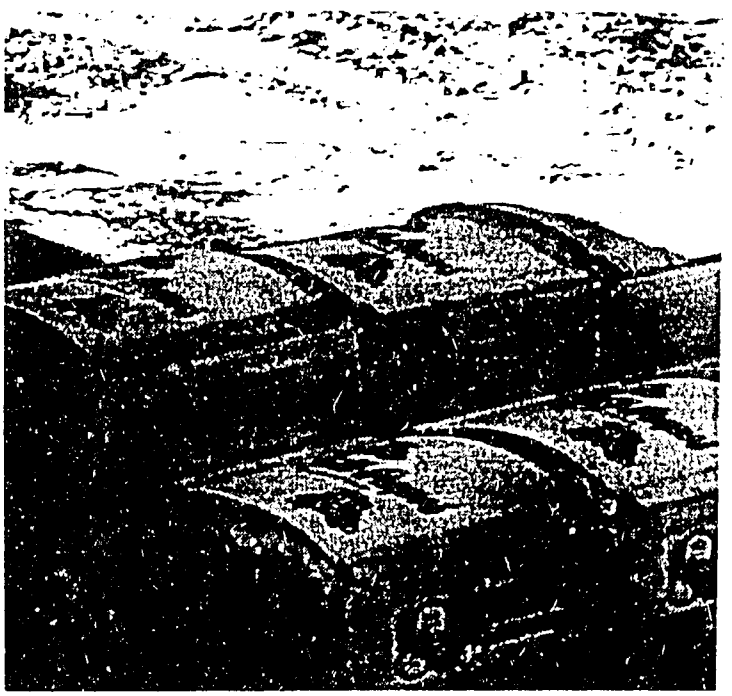
Each packing station handles the production of about four harvesters. At the packing station, the grapes are again trimmed for size and shape, if needed (usually not), and packed into shipping packages.

The packages are weighed to ensure proper amount and labels are added. With this system there is more overall control and more consistent quality through the pick.

For packinghouse packing, grapes are selected from the vine, picked, but usually not trimmed. They are placed in field boxes (field lugs) and set in the middle of the rows. The lugs are put onto truck beds and transported to the packinghouse.

There are some points common to both systems. Sanitation in the field and the packing-

house is important. Remove decayed material. Harvest as early in the morning as possible to maintain a low field heat. Grape bunches should be handled by the stem. Do not bang bunches together. The grapes are covered by a natural, waxy "bloom". When rubbed, the luster disappears. Lack of bloom is, therefore, an indication of rough handling and is something receivers look for in assessing quality. Do not overfill the boxes. When stacked, the fruit in the lower box must not touch the bottom of the upper box. Provide shade for the boxes if they must wait for pickup and transport to the packinghouse or to the shipping point.



2. Transport from the Field.

Do not throw the filled boxes onto the truck or wagon. Do not stack over-filled containers on top of each other. The container should support the weight, not the grapes. Tie down containers, if possible, to prevent bouncing. If under your control, have ruts and deep holes in farm roads filled and smoothed to avoid bruising and jarring of fruit. The load should be covered with a top to avoid sun injury and heating up of the top layer of fruit. If bouncing and jarring are unavoidable due to road conditions, a cover will help to keep the fruit from bouncing around within and out of the containers.

Z. Shed or House Packing

1. Receiving Fruit from the Field.

For packinghouse operations, if the fruit containers cannot be immediately used on the packing-house line and cannot go into a cooler, provide shade while waiting.

2. Dumping/Grading/Packing.

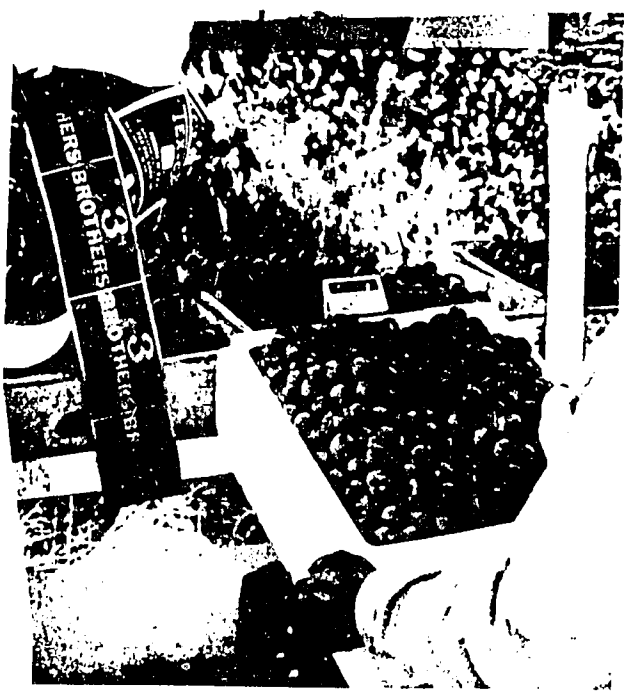
At the house, the lugs are removed from the field truck and gently dumped onto a traveling belt, or workers select bunches directly out of the lugs. The bunches are trimmed for shape and size and packed into shipping containers. Here there is more room and better working conditions. The environment is consistent and grading/selection is easier.

Several grades or types of packs can be done at a time by each worker. Often a worker will have 4 different packs (grades or size) being filled at a time. As the worker picks up a bunch, it is trimmed and placed in the appropriate box. It is very important to know the desires of the market when selecting and trimming. Some customers like only conical shaped bunches, while others prefer flat, spread out bunches. Certain European markets only take bunches with large (2-3 cm) grapes.

Others want hundreds of small berries. Sort by color and size. Uniform packs of any color and size are better than any packs varying in color and size. Usually, workers find it easier to sort first by color, and then within a color, to sort by size and shape.

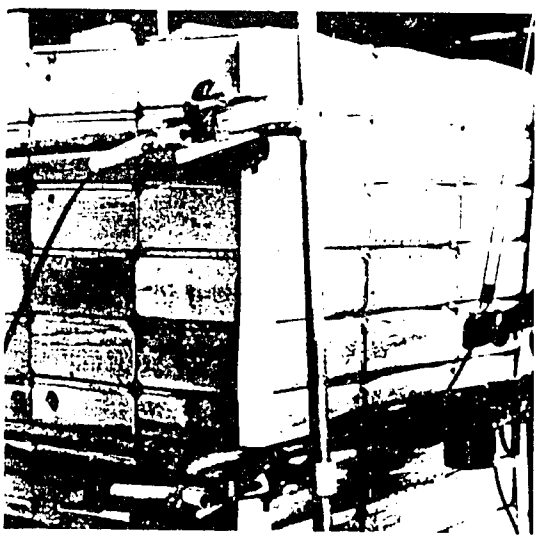
Grades and standards are a means of communication. They allow buyers and sellers to understand each other. In the United States, if a buyer specifies a particular grade and color according to the United States Department of Agriculture published grades and standards (see Appendix B, Standards for Grades of Table Grapes), the seller knows exactly what the buyer wants, and can ship them the proper selection, without the buyer ever actually inspecting the fruit before it is shipped. Normally, the buyer will inspect the arrived shipment to ensure that the seller did indeed ship what was requested and to ensure that the seller was following the approved descriptions. However, some shippers from some countries (Holland for example) have such an excellent reputation for meeting the requested standards that their product is not even inspected when it arrives, but is delivered on to retail markets unopened and even receives a premium because of the reputation for quality adherence.

All fruit should be packed into clean new, boxes. Sanitation is very important. The lug is usually constructed of wooden ends and fiberboard sides and bottom. The top lid is plastic or fiberboard, with tabs that fit into the sides, so nailing is not needed. Typical dimensions of the shipping lug are 41 cm long (inside) x 34 to 36 cm wide (outside) x 11 to 14 cm deep (inside). When packed, they weigh 10.5 to 11 kg. It is most common to pack a "naked pack" (no wrap on the cluster).



However, it is increasingly common to find the clusters first placed into a plastic sleeve or net before placement into the shipping package. The wrap, besides giving some protection to the berries and helping maintain a high humidity, helps prevent shatter. When shatter does occur, the berries still stay with the bunch and can still be sold with the bunch. When packing "naked", the bottom of the lug is lined with a paper pad. There should be slits or vent openings in the cushion to allow for airflow. The bunches are arranged in the lug with a slight "crown" or bulge in the middle so that when the lid is attached, there is a slight compression of the fruit to help prevent shifting and vibration damage. This compression, though, should not be so much as to injure the fruit. Some packers place an additional cushion underneath the lid before closing.

The lugs should usually be placed on a pallet for export since most receiving markets demand this type of handling.

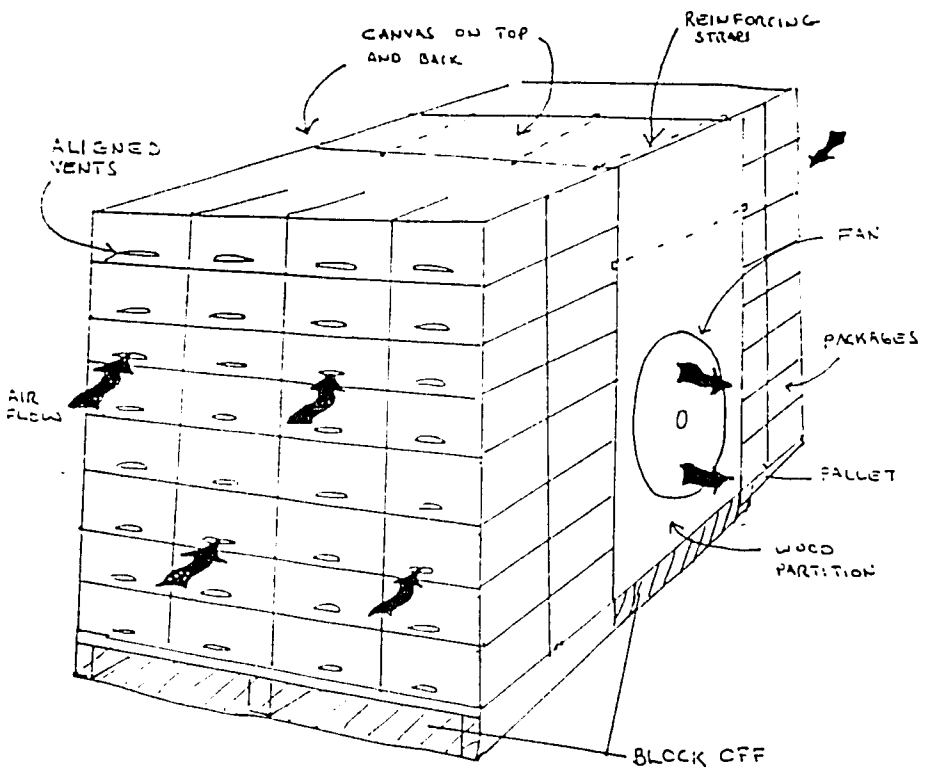


Pallet sizes vary per market. An international standard is developing which is 102 by 120 cm. By placing the pallet in a corner, or building a two sided frame in which the pallet can sit, boxes can easily be stacked neatly on the pallet by using the corner walls or frames as a guide. The boxes should be stacked on the pallet in such a way that the vent holes line up with neighboring packages to ensure adequate airflow. Stack the pallet 10 boxes high or usually about 1.7 m high, according to the requests of the market and the physical limitations of the shipping vehicle. Strap (tie) the boxes down onto the pallet to prevent shifting.

AA. Cooling

Cooling is absolutely essential for the marketing of top quality grapes, whether the grapes have been field packed or house packed. Often, small growers do not have the facilities to cool grapes and they are loaded warm into refrigerated vehicles or even transported without temperature control. These grapes will only be suitable for local markets, since they will begin to deteriorate within hours of being harvested. Prompt cooling of the grapes is required for optimum quality and acceptance by the major import receiving markets. This minimizes water loss, retards decay, does not let pathogens get a "foot hold" or "headstart", and quickly reduces the respiration (and deterioration) of the fruit. Not only should grapes be refrigerated after harvest, but they should be precooled prior to refrigerated storage or transport. Precooling is a method of rapidly removing heat from the grapes by forced air and bringing the grapes down to 0°C as quickly as possible. Not only is precooling needed, but it should be initiated as soon as possible after harvest. If the temperature is near 38°C in the field, a delay of 4 hours before precooling will double the degree occurrence of dry stems, soft berries, brown stems, and increase weight loss over six fold as compared to precooling immediately at harvest.

If packaged grapes are placed in a cold room and allowed to passively come down to the room temperature, two days may be necessary for two pallets, depending on the airflow in the room and the cooling capacity of the refrigeration unit. If in this same room air is forced into the lugs by establishing a pressure gradient across the lug, the grapes can reach room temperature in 8 hours. Two pallets are stacked side by side, with about 0.5 meter between them. A canvas tarp is placed over one side of the opening between the pallets and over the top. It is reinforced with strips of wood, metal or plastic. On the other side of the opening, a fan is placed to pull the air out of the space between the two pallets. This causes a low pressure to develop between the pallets. The cold room air is drawn (forced) through the lugs and cooling is rapid. This type of precooling is called forced-air cooling or pressure cooling, and is much more efficient because the cold air is brought into direct contact with the fruit rather than just the outside of the package, as in passive room cooling. Pressure cooling can be done with just a few lugs, or with several pallets. It is very important that the packages (lugs) have ventilation holes which line up to allow the air to flow through the packages. Inside liners must not restrict this flow.



Also, openings in pallets for fork lift trucks should be sealed to prevent the air from bypassing the grapes.

It is very important to understand that once the grapes have been cooled, they must not be allowed to come in contact with warm ambient air. This will cause moisture to collect on the package material and on the fruit itself, inviting decay and damaged packages. For high quality grapes, it is necessary to cool the grapes, and then essential to keep them cold.

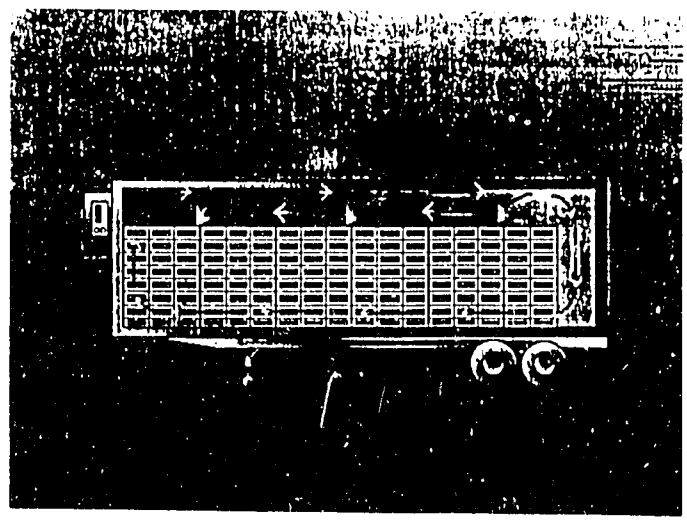
AB. Fumigation with Sulfur Dioxide

If possible, it is best to not fumigate grapes with sulfur dioxide. It can damage the grapes, is an environmental hazard, and can injure workers if inhaled in sufficient quantity. Fumigation is probably not necessay if decay loads are light, good sanitation is practiced, berries are handled properly (not harvested wet), transit or storage times are short (1 to 2 weeks), precooling is practiced immediately after packing (within hours of harvest) and temperatures during storage and transport are kept near freezing. However, because of the decay problems associated with grapes, coupled with sometimes necessary longer storage and transport times, and the fact that the above ideal handling practices are not always followed, the surface of the berries is much of the time sterilized after packing with sulfur dioxide, and often every week for long term storage. After the berries are cooled, the pallets are placed in sealed fumigation rooms. For best results, this is done within 12 hours of harvest. For the initial fumigation, a concentration of 0.5% sulfur dioxide by volume (0.1% for subsequent weekly fumigations) for 20 minutes is typical. One kg of sulfur dioxide takes up 0.156 cubic meter at 0°C.

Hot gas method. Up to 5 kg can be delivered with this method at a rate of 0.5 kg a minute. A tank of sulfur dioxide is hooked to a delivery line and the valve is opened. The tank is placed in hot (boiling) water, with the tank and the water on a scale. The proper weight of sulfur dioxide is allowed to flow into the fumigation chamber and is monitored by observing the indicated weight change on the scale. Adequate fans in the fumigation chamber must distribute the gas quickly and uniformly. After the time period, the tank is removed from the water and the valve is closed. The fumigation room is vented. There should be an intake near ground level (which can be sealed during fumigation) and an exhaust stack on the roof to allow safe exhausting of the gas. Every precaution should be taken so that workers are not exposed to the sulfur dioxide. Excessive sulfur dioxide can cause small, white, bleached spots on the berries (where natural non-cutinized openings are), or anywhere where the skin has been damaged.

AC. Transport & Storage

The environmental requirements for grapes are simple. Keep them at the highest humidity and as close to freezing as possible until consumption. Avoid vibration and rough roads, if possible, during transport. If the shipping vehicle is equipped with bottom air delivery, ventilation holes should be in the top and bottom of the lugs which line up their neighbors above and below. If the vehicle has top air delivery, air passage horizontally through the load should be encouraged either by stacking pattern or by ventilation holes in the sides of the lugs.



The load should be well braced to prevent shifting. If possible, ground transport vehicles should have air cushion suspension. If transport time will be great (3 weeks or longer) and decay is suspected, the load should be fumigated before loading. This should take place about 2 days before loading to allow excessive sulfur dioxide gas to leave the grapes. It is not recommended, because of physical restrictions, to gas the grapes in the transport vehicle. A slow-release sulfur dioxide generator can be placed in the lugs if needed. These are pads containing sodium bisulfite which release sulfur dioxide. They can be obtained by contacting Uvas Quality Packaging Inc., P.O. Box 369, Antioch, California, USA 94509. This will give protection for up to two months, providing an initial fumigation was done prior to loading. However, it is an added expense, and the sulfur dioxide can still cause problems, especially when the lugs are rewarmed during wholesale marketing. If traveling by air freight, the load should be precooled and the air freight container loaded inside the cold room, if space permits. The container should be transported

and placed on board within 4 hours. Most air freight containers are not refrigerated and have poor air circulation. Upon arrival at the airport, they often sit in the sun on the runway waiting for loading. Temperatures can reach 40° to 50°C inside these containers. Once airborne, they can become frozen unless the cargo area is heated. If carbon dioxide is used as a cooling agent in the container, it should not contact the grapes directly since high carbon dioxide levels can damage grapes by turning the pulp brown. The cooling should be done through a heat exchanger and the carbon dioxide should be vented to the outside of the container.

AD. RECAP

Harvest early in the day when it is cool. Do initial selection in the field. Harvest, grade, and pack into shipping lugs in the field, or harvest into field lugs and transport to packinghouse for grading. Keep shaded. Transport to packinghouse and dump gently on line. Grade and sort according to customer requirements. Precool grapes to 0°C as soon as possible after harvest and packing. Fumigate only if necessary, but within 12 hours of harvest. Store or transport 0°C. Fumigate every week during storage if needed. If sulfur dioxide is needed, in some instances slow release generators can be added to the lugs for transport.

Glossary of Terms

Alcoholic fermentation: A condition resulting from a lack of oxygen that results in an odd flavor and odor.

Arm: An extension of the cordon containing the spurs.

Berry thinning: The process of removing portions of the cluster. This may include the lower 1/3 to 1/2 of the cluster or branches from the cluster rachis or both.

Bilateral Cordon: A system of vine training that divides the trunk into two permanent branches, each extending in opposite directions down the vine row and horizontally supported on a trellis wire; commonly referred to as cordon training. The vines are spur pruned.

Bloom: A natural waxy coating on the surface of fruit.

Cane: Mature (woody) shot

Catch Wire: A wire which serves as an attachment for developing shoots. This wire is also used in training cordon-trained vines to prevent downward turning of the cordon due to crop weight.

Cluster Thinning: Removal of entire clusters after fruit set.

Color Girdle: Girdling of the vine when color first begins to develop on the fruit. This increases the color and maturity of many varieties.

Cordon: A horizontal extension of the trunk.

Crossarm: A horizontal or slanting cross piece, usually 18"-42" long, attached at or near the top of the stake to extend the width of the trellis. Wires are attached at each end of the crossarm. Additional wires may be added between the outer wires on the wider crossarms.

Dry Shatter: Clean separation of grape from stem.

Ethephon (Ethrel [Registered]): A synthetic plant growth regulator used to enhance color on many grape varieties. Usually applied as a spray when color first begins to develop on the berries. Ethrel [Registered] is a Union Carbide product name.

Flower Cluster Thinning: The process of removing unwanted flower clusters from the vine. Performed prior to bloom when shoots are 15-20 inches long.

Flower Thinning: The process of removing individual flowers from the cluster branches prior to bloom. This may be done by hand (finger thinning) or by brushing with a Solo Beauty brush. Usually performed on the Perlette variety.

Fruit Set: A stage of development one to three weeks after blossoming when most of the flowers have fallen and those remaining have set and developed into berries. Also called berry set stage or shatter stage, fruit set is preferred.

Gibberellic Acid (Gibberellin): A natural plant growth regulator sprayed onto many seedless grape varieties to reduce fruit set (bloom sprays) or to increase the size of the berries (sizing sprays).

Gibberellin(s): A plant growth regulator currently used for bloom thinning in Thompson Seedless and a few other varieties, berry enlargement of seedless varieties, and reduction of berry shrivel in Emperor.

Girdling: The removal of a complete ring of outer and inner bark from a shoot, cane, or trunk. Also called ringing. This process temporarily interrupts the downward translocation of metabolites.

Head: The upper portion of a vine consisting of the top of the trunk and arms.

Lateral: (1) A branch of the main axis of a cluster. (2) A side shoot arising from the lateral bud on the main shoot.

Lug: A field box for grape packaging.

Nematode: A small parasitic worm.

Node: The enlarged portion of a cane or shoot at which leaves, clusters, tendrils, and/or buds are located at regular intervals.

Overcropping: The production of more crop than the vine can bring to maturity at normal harvest time.

Part Per Million (ppm): A unit of measure used in making chemical solutions. It refers to one part of ingredient in one million parts of water solution on a weight basis.

Pathogen: An organism capable of causing disease.

Rachis: The main part of the cluster stem.

Shoot: The present season's growth, contains leaves and fruit clusters.

Shoot Removal or Deshooting: Removal of unwanted shoots on the trunk of a vine below the head.

Shoot Thinning: The removal of unwanted shoot growth from the head, cordon or arms of a vine when the shoots are short, usually 3"-15" long.

Shot Berry: Very small berries that fail to develop to normal size, usually seedless.

Shoulders: Well developed laterals at the base (point of attachment) of the cluster.

Size Girdle: Girdling of the vine early in the season when the berries are rapidly increasing in size. Generally applies when the berries reach 3/16 to 5/16 inch in diameter. This causes the berries to enlarge which results in larger berries at harvest.

Spur: A cane which is cut back two or three buds.

Tendril: A slender twining organ on a shoot opposite a leaf that can coil around an object for support.

Trellis: A permanent vine supporting system consisting of a stake and one wire at a minimum, and at a maximum, a stake plus one or more crossarms with additional wires on an arbor system.

Trunk: The main stem or body of a vine between the roots and the head of the vine.

Veraison: Beginning of fruit ripening as indicated by softening of the berry and/or the beginning of color development.

Vital Heat: Heat released by grapes as a result of metabolic activity.

Wet Shatter: Separation of grape from stem with wet tissue remaining on the stem.

Wing: A well developed basal cluster branch, appearing separated from the main cluster.

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