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GROWING GRAPES

IN
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Growing Grapes in Nebraska

C. C. Wiggins ^{1/}

The grape is one of the most generally grown fruits in Nebraska. A few vines in the backyard of a city property or along one side of the farm garden supply fruits for jams, jellies and juices at a minimum of cost and labor. As a commercial crop, grapes have been profitably grown in the eastern counties because of the adapted soil and climate and the nearby markets. Thirty years ago grapes were shipped in large quantities from such centers as Brownville, Florence, Peru and Lincoln but the dry years in the thirties and the severe freeze of 1940 eliminated many plantings. Grape plants 75 years or more of age are still producing grapes in the loess soils along the Missouri River. The latest census reports indicate that Nebraska grape production, although still over 1,000,000 pounds annually, is now less than 40 per cent of what it was 25 years ago. A large proportion of the total production is now derived from home plantings rather than from commercial acreages.

Grape production for home use is relatively simple. Proper selection of varieties, regular attention to pruning and cultivation, and the occasional application of protective sprays will insure satisfactory crops in most years. Grape fruit buds, like the buds of all other fruits, are susceptible to frost damage but they make relatively little growth until temperatures reach 50°-55° F. Hence spring frost damage occurs only in exceptional seasons. Hailstorms, however, are always damaging to the grape crop because of the fruit-splitting which results. Many varieties are not winter hardy in central and western Nebraska. Only proven varieties should be planted in those areas unless adequate winter protection can be provided.

General Considerations

Soils The grape does best on a loose, warm loam but many successful plantings are found on gravelly or sandy soils. Clay soils are difficult to work and should be avoided. The loess formations in the Missouri River hills are ideal for this fruit.

Subsoil conditions are also important. A high water table or poor surface drainage always causes trouble. Grape roots in loess soils have been found at depths of 25 feet or more on the University Fruit Farm at Union, but soils of this depth are not essential to good grape production. Clay mixed with sandy soils improves their water holding capacity and increases fertility. Soil fertility should be such that the mature fruiting canes reach the diameter of a lead pencil when measured at the fifth or sixth internode from the base of the cane.

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The fertility of the average well-cared-for Nebraska soil is usually high enough for grape production. Excessive fertility produces heavy canes and foliage, but fruit clusters are scarce. On the other hand, poor soils are unsatisfactory since the cane growth is too weak for good fruitfulness.

Sites . The development of high sugar content and proper flavor requires varying amounts of summer heat, depending upon the variety. Thus, late varieties fail to mature properly in most seasons in the northern and western parts of the state, and in all parts of the state in exceptionally cool seasons. It is worthwhile, therefore, to choose south or southeast slopes whenever immaturity is likely to become an important factor. Such exposures often result in less winter injury too, although the possibility of spring frost damage may be increased somewhat because of the earlier growth.

Rough, hilly lands have all too frequently been used for grapes, perhaps because many European vineyards are found on such land. However, in the Old World erosion is much less of a problem, and every means is taken to minimize the erosion that does naturally occur. In Nebraska, steep terrain should be avoided for vineyard use, or contour planting should be employed. Even under the best conditions some top soil will be lost because of the necessary cultural operations. The late blooming habit gives the grape considerable immunity from late frost damage, and this safety factor can be increased if the vineyard is adjacent to a lower area into which cold air may drain on those calm spring nights when frosts occur. Surface drainage is essential wherever the vineyard is planted. Where lack of water is likely to be more serious than losses from frosts, the slope may be abandoned for the better water supply of the bottoms. This is sometimes done in the Platte Valley area.

Propagation . The grape is easily propagated by either cuttings or layers. Most growers, however, will probably prefer to purchase the inexpensive rooted cuttings from the commercial propagator rather than bother with home propagation. Nursery-grown plants should always be of No. 1 grade but may be either one or two years old. The former are often lower in price, can be set more easily and generally are preferred by the commercial grower. Regardless of grade, age or price every purchased plant should possess a vigorous and extensive root system and at least one strong shoot above the ground.

If home propagation is preferred, **layering** offers an almost fool-proof method of filling in a vacancy in the row or of providing a limited number of new plants of a favorite variety. Strong one-year canes are selected, bent to the ground and covered with several inches of well packed soil at one or more points. Notching or girdling the cane just below a buried node will hasten the rooting process while a weight above the covered portion will hold the cane in closer contact with the moist soil. Layering is usually done in early spring, and after one or two seasons' growth the newly rooted plant is ready for transplanting. As replacement for a missing vine the covered area is

placed at the point where the new plant is wanted - then no transplanting is necessary.

If more rapid propagation is desired, **cuttings** should be used. Cuttings containing at least two buds are made preferably in late fall or early winter from vigorous, well matured canes of medium size. Long jointed water sprouts and weak winter-damaged canes are not suitable propagative material. Canes cut off in the pruning operation are sometimes used but may not be satisfactory because of winter injury. Certain varieties sometimes require special treatment if a satisfactory rooting percentage is to be secured.

The cuttings are tied into bundles and then packed in slightly dampened sand or peat moss in a cool storage cellar or an outdoor pit located so that good surface drainage is assured. They should be kept just damp enough so that neither drying out nor rotting will occur, and at a temperature below the point where bud growth begins (45° F.). The lower end of the cutting (made just below a node) will callus over and quick root growth can be expected in the spring. As soon as the soil begins to warm up the callused cuttings are set 6 inches apart in rows 3 1/2 feet apart so that only one bud remains above ground. Extra long cuttings are sometimes set on a slant so that the bottom node, the region from which roots are expected to arise, is not placed in such cool soil. Usually a high percentage of rooting is secured and good cultural care and seasonal conditions will produce a usable plant in a single season. If a second year in the nursery row is required all stems but one strong one produced the first year should be pruned off and the remaining one cut back to two buds.

Some use has been made of **graftage** to get weak growing varieties on stronger growing stocks, or on stocks that are disease or insect resistant. This practice is general in California and in Europe where the **vinifera** varieties are grown, but is seldom used with native sorts. Strays in the vineyard, however, can be grafted to the desired sort by **top-working**. In this case the old stem is sawed off at or below the soil line and a notch or cleft is made in this stump. A dormant scion (one-year cane) 3 to 5 inches long of the variety to be propagated and containing one bud is shaped to fit the cleft and inserted in such a fashion that the inner bark lines of stock and scion have contact. Two or more scions may be used on each stump but eventually only one is allowed to remain. Top grafting is done just as bud growth begins. No wax is necessary but the union should be covered with soil. This method offers a means of changing an unfruitful wild plant which may be growing on an arbor or fence into one producing good fruit.

Varieties

Hundreds of grape varieties have been described, propagated and offered for sale by nurserymen. Many of these are simply superior wildlings that have been brought into cultivation and have given a good account of themselves. Several species are native to various parts of the country and each species has its own climatic adaptation. In recent decades, however, plant breeders have, by

hybridization, combined the desirable characteristics of several species or varieties and produced the varieties which are in general use today. New improved sorts lie ahead but the introduction and wide distribution of new sorts of such long-lived species as the grape is a very slow process. Varieties for general use in Nebraska contain largely the characters found only in native American species but a few of them do have a bit of **vinifera** blood in their ancestry.

Grape varieties must be chosen in accordance with the prospective location of the vineyard and also to fit the use to be made of the product. Commercially only the blue and purple sorts are in market demand. Most purchasers prefer these colors regardless of the higher sugar content and more delicate flavor of some of the red and white varieties. This fact, however, should not deter the homeowner from using some of the latter sorts when there is no intention of selling the fruit.

Below are listed a number of varieties which can be expected to do reasonably well in Nebraska. Most varieties are self-fruitful and hence will be productive even when only a single variety is planted. Brief notes on their characteristics and uses are given.

PURPLE, BLUE OR BLACK

Concord - the outstanding variety for either home or commercial production - too late for western Nebraska - vigorous - productive - widely adapted as to soil - clusters loose and medium in size - quality good. **Fredonia** - two weeks earlier than Concord - a new introduction from New York - clusters large - a very satisfactory early sort. **Worden** - a thin-skinned, high quality sort which may be used some in the western part of the state - ripens a week or ten days ahead of Concord. **Beta** - an extremely vigorous, very hardy variety - subject to attacks from phylloxera (root lice) - clusters small - medium quality. **Blue Jay** - a recent Minnesota production reported to be very hardy - quality not very high.

RED

Lucille, Brighton and Caco - high quality varieties listed in their approximate ripening order - clusters large and often loose - "shelling" quite common, particularly if mildew is present or thrips are abundant. Deterioration of berries is quite rapid. Brighton needs cross pollination. **Delaware** - very high in quality - small clusters - weak grower - shy producer.

Red Amber - another hardy Minnesota variety.

WHITE

Portland, Diamond and Niagara - all of good quality - ripening date well ahead of Concord - clusters large - berries rot readily and are easily separated from cluster - sometimes winterkill, even in eastern Nebraska. **Moonbeam** - another new variety from Minnesota - recommended for use in severe climates.

Cultural Directions

Spacing . . Grape plants of most varieties should be set at least 8 feet apart in rows which should never be less than 10 feet apart. Spacings 8 X 8 or 8 X 9 are frequently seen but these narrower rows do not accommodate most of the power tools now used in cultivation. Somewhat closer spacing in the row may be used for weak growing varieties or where a high trellis is used. Plants to cover an arbor may be only 4 feet apart but such a structure is usually at least 8 feet high and hence provides necessary room for proper leaf development and cane distribution.

Rows running north and south provide a better distribution of sunshine but with wide rows this is much less significant than a row direction that will hold soil erosion to a minimum. In some Nebraska vineyards, soil loss has been as much as 12 inches in depth when the rows run up and down the slope. Contour planting is very satisfactory but does increase the trellis maintenance problem.

Plants and planting. Regardless of age or grade of plants purchased the buyer should insist upon thrifty plants with good root systems. Roots arise only from the nodal regions and there may be two sets of roots on a given plant if a three-node cutting was used for propagative purposes. The upper set of roots is generally cut off and exceptionally long roots in the lower set are cut back to 8 to 10 inches. In no case should the roots be allowed to dry out. Plants somewhat dry when received can be revived by a few hours' soaking. Unless immediate planting can be done, the bundle should be opened, the roots spread out in a trench and moist soil firmly packed about them. This heeling-in procedure will carry the nursery stock for several days when planting is delayed by unfavorable circumstances.

Spring planting is always preferable. Fall planting often results in winterkilling because of drying out, unless the plant is watered well and then entirely covered with soil after the top has been properly pruned back.

Fall plowing of the prospective vineyard site makes possible earlier spring planting. Grapes are very easily planted if good soil preparation precedes the planting operation. A two-man team makes a good combination - one man to dig the holes, the other to take the individual plant from the bundle, trim off the straggling roots and superfluous top, and pack moist soil tightly around the roots after they have been spread out in the hole. The final step is to cut back the strong remaining stem to two buds.

When larger acreages are to be planted some operations such as digging the hole may be mechanized, but pruning the root and top and packing the soil around the newly set plant will always remain hand operations. Holes must never be opened far ahead of actual planting. This results in severe soil drying.

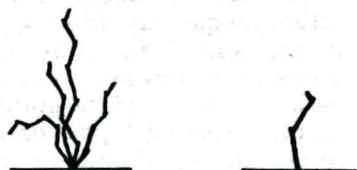


Fig. 1 - Plant pruned at planting time

Occasionally, the question of transplanting old vines arises. This can be done but crops are slow in coming. If an old plant must be moved all top growth is cut off within a few inches of the ground and as much of the root system retained as is practicable. Trenching, the season preceding transplanting, to a depth of 18 inches at a distance of 2 feet from the trunk will improve the chance of survival. Almost without exception a newly rooted plant is preferable to an old transplanted one.

Soil care. To fruit successfully the grape each year must produce a supply of medium-sized shoots. In essence this means that the vineyard must be kept under continual cultivation or some other means found to eliminate competition from plants such as weeds or grass. Extremely late cultivation, however, may encourage late growth which is subject to winterkilling and hence cultivation generally ceases in July. A cover crop may be sown later or the natural cover of foxtail and weeds be allowed to develop. Grapes grow very well under a straw mulch but the mulch must be kept heavy enough to check weed development. A mulch interferes seriously with the removal of prunings from a commercial planting.

Level cultivation is not always possible but on contour planting some ridging of the rows will aid in holding rainfall in place. Reversible orchard discs are the common cultural tools but some hand work is almost unavoidable. In recent years the use of one of the herbicides (Dinitro compound) has looked promising for controlling growth under the vines. It must always be used so as not to cover foliage parts of the grape. The grape is very susceptible to damage from 2, 4-D.

During the first one or two years of the life of the vineyard, the space between the rows may be used to produce a cash crop. It should always be a hoed crop such as tomatoes, potatoes or sweet corn rather than any of the grasses or even a strong growing vine crop such as pumpkins or winter squash. Strawberries may also be used but should never be left beyond the second year. Whatever the crop, it should never hinder the growth of the grape plants.

Overstimulation of growth is undesirable. The very vigorous canes with long internodes are never very fruitful. Buds on well developed laterals from such canes, however, will sometimes produce satisfactorily. Vineyards planted on soils of average fertility need little attention so far as fertilizer applications are concerned.

In certain areas in the state a chlorotic or yellowish leaf condition frequently develops because of a deficiency of available iron in the soil. In some of these cases, found mostly in central and western Nebraska, relief can be obtained by spraying the foliage with ferrous sulfate solution (1 teaspoonful per gallon of water) or by distributing 5 pounds of the same material per 100 feet of row. Applications should be made on an experimental basis to verify beneficial effects before the whole planting is treated. An application of manure at the same time tends to make the ferrous sulfate more effective.

Pruning. The purpose of pruning is to maintain proper balance between fruit production and development of adequate wood for the succeeding crop. It also keeps the plants within manageable limits. The grape fruits on shoots from the buds on last year's canes, but only if these canes are of sufficient vigor. The shoots from the first and second buds from the base of the cane are generally non-fruiting but those from the other buds on the cane are capable of producing one or more clusters of fruit. Heaviest production generally occurs at bud No. 7. If for any reason the main shoot from a bud is injured one or more secondary shoots will develop but their production will probably not exceed 25 per cent of that of the primary shoot.

The grape must be **pruned annually**. A single year's neglect on a young vine will result in the development of a great many weak unfruitful canes. With older vines the result is an enormous number of clusters for the current year and such weak vegetative growth that the plant is unfruitful the next year.

Pruning systems refer to the length, number and disposition of canes and spurs upon the supporting trellis. Various systems such as Kniffin, fan, etc., are used in different grape growing areas and each one has its particular advantages. For Nebraska the Kniffin and fan systems are most generally used. In the **Kniffin** system 40 to 60 fruiting buds are left on each vine, according to its vigor. These are distributed on a trunk reaching to the top trellis wire in four to six canes, each of which is eight to ten buds long, and a couple of two-bud spurs. In the **fan** system, recommended for varieties and areas susceptible to winter damage, the canes originate near the soil level and no trunk is present, although the amount of wood left is about the same as with the Kniffin system. The very pliable stems are readily covered with soil for winter protection.

The recommended **pruning time** is the latter part of the dormant season. Fall pruning may result in some drying back from the cut end with the killing of one or more buds. Vines are very brittle when frozen and hence should not be handled while in that condition. Vines "bleed" badly from wounded surfaces after spring growth activity begins because of the increased root pressure. Such bleeding has no effect upon plant vigor despite the widespread popular idea that it weakens the vines. Summer pruning has no influence on yield. It may, however, be valuable in training and sometimes also by improving aeration.

First-year pruning. after the shaping at transplanting time, consists wholly of confining growth to the later-needed stem or stems. A vigorous transplant develops many shoots, all of which should be taken off except the one which is to become the trunk of the new plant. If this growth is strong enough to reach the top trellis wire, developing laterals on it should be restricted to two to four at appropriate levels. This treatment presupposes the erection of a trellis the first season or the use of individual stakes to which the developing plants can be tied.

In the case of weaker plants or those which do not begin growth promptly the new growth will not be so vigorous - in fact it may reach only the bottom trellis wire. Even here, however, all growth should be restricted to a single stem by rubbing off competing shoots.

Second-year pruning will depend upon the vigor of the preceding year's growth. Strong stems - one for each plant - are cut off at the top wire level and all laterals generally removed. Such a plant may produce a few clusters of fruit the second season. If, however, only a short stem was produced or the strong one killed back by winter injury it may be only long enough to reach the lower trellis wire. In extreme cases this stem may even be cut back to two buds.

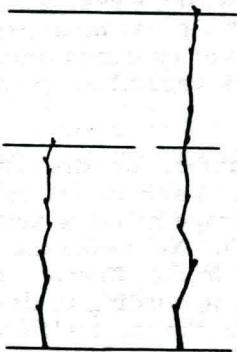


Fig. 2 - Pruned plants after one year in vineyard. A strong-growing plant at the right.

During the second summer pinching out undesired shoots will aid materially in developing a strong trunk and good fruiting canes for the next year. The selected laterals may in turn produce laterals themselves as the season advances but these should be permitted to grow.

Pruning in the third and later years is primarily to influence the quantity and quality of fruit produced. Canes (shoots of the preceding year) the size of a lead pencil or slightly larger should be selected. Tests have shown that canes less than $1/4$ inch in diameter are unsatisfactory and likewise that those over $1/3$ inch in diameter are not well suited for fruit production. These measurements refer to cane diameter between the fifth and sixth nodes. Internodes should be 5 to 7 inches in length.

The number and length of fruiting canes left on each plant depends upon the vigor of that plant. Thus, three to four canes each with six to eight buds may be ample for a three-year-old vine or for a less vigorous older one. Mature Concord plants, however, may sometimes carry as many as 60 to 70 fruiting buds on four to six canes. Weaker plants, or weak growing varieties such as Delaware, are pruned in proportion to the amount of growth - the weaker the growth, the more severe the pruning.

Two or three **renewal spurs** increase the probabilities for development of several good fruiting canes for the next year. Such canes two or three buds in length eliminate the

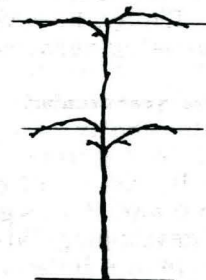


Fig. 3 - Plant pruned after its second year in the vineyard. Note the strong canes and renewal spurs.

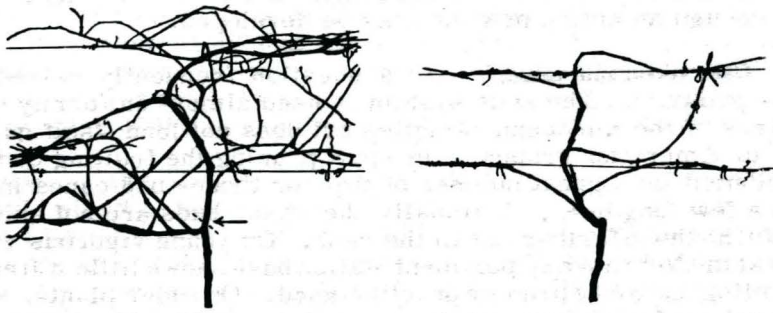


Fig. 4 - Mature, vigorous plants before and after pruning. The trunk was cut off at the point indicated and the remaining stem straightened up to become the new trunk. This is a method of replacing older parts of the trunk with younger, more vigorous plants.

necessity of retaining so much old wood. Since wood older than the canes from last year is not fruitful, as much of it as possible, aside from the trunk, should be eliminated each year.

Arbor grapes need annual pruning to provide the proper balance between fruit and cane growth. Usually a much longer trunk and more but shorter canes are needed. The objective here is to provide shade at a relatively early date and hence a larger number of buds are left on the plant. Fruit production, however, may be adversely affected by this procedure. With the trunk reaching up the side and a part of the way across the top of the arbor, the numerous short canes will give a quick shade. Under these circumstances the spacing between plants will probably be less than recommended for the vineyard.

The arbor is often covered with plants that bloom but produce little fruit. These are usually wild plants and the nonfruitfulness is due to the lack of pistillate flowers. The only remedy is to cut off the trunk and top-work it with scions from a fruitful variety. Directions for this operation have already been given.

Renovation pruning is the term applied to the process of bringing an old, long-neglected plant back under control and thus restoring its fruitfulness. This must be a gradual process lasting over two or more seasons. Usually satisfactory fruiting canes are scarce and are located far from the root system. Several trunks may also be present. Select the best four to six canes that are nearest the root system - then cut off all other parts. If these canes can be concentrated on two or three trunks so much the better. The heavy pruning will stimulate strong new canes closer to the root system

and perhaps even some strong watersprouts. The following year more of the old wood can be cut away. If the process is continued long enough an entire new top may be developed.

Cane versus spur pruning is a question frequently raised by grape growers. The spur system is used almost uniformly by the growers of the European varieties but does not lend itself quite so well to American grapes. In spur pruning the fruiting buds are distributed on a great number of two- or three- bud canes instead of on a few long ones. Actually the basal buds are not quite so fruitful as those farther out in the cane. On young vigorous vines, tests at the Nebraska Experiment Station have shown little difference in fruiting due to the pruning practice used. On older plants, where the vigorous fruitful canes are not very plentiful, spur pruning may result in just a shearing process in which the basal buds on all canes are permitted to remain. This overloads the plant because of the excessive number of buds and results in poorer bunches. The proportion of old wood is significantly greater on the spur-pruned plants, particularly as they grow older. It is possible that a combination of spur and cane pruning can be used profitably on some vines. If spur pruning is to be followed care must be exercised so that only the bases of strong canes are saved and that the total number of buds left compares favorably with those left on a cane-pruned plant.

Trunk renewal must be given attention as circumstances demand. With age the old trunk greatly increases in size and often becomes weakened from disease, sunscald, etc. It can be replaced over a two-year period by one of the strong watersprouts or suckers. Cut this new cane off at the top wire level and tie it in place. Canes from the old trunk should be so manipulated that they do not overshadow cane development on this prospective trunk. The final step is to save canes from this new growth at the next pruning and cut out the old trunk. In Nebraska vineyards that are 25 or more years of age this trunk renewal process has been repeated many times.

Brush removal is a simple operation when only a few vines are involved but becomes quite a task in the long rows of a commercial planting. It is essential, however, that prunings be removed because of their interference with cultural operations. They should be burned immediately, particularly if cane borer infestation is present. One of the simplest ways to do this job is through the use of a gin pole. A long straight pole, of hedge if it is available, is rounded off at the butt end and a chain or strong rope is fastened to it at a point $2\frac{1}{2}$ to 3 feet from the base. This chain or rope, which must be considerably longer than the pole, is then fastened to a tractor or some horse-drawn equipment. One man holds the long end of the pole, keeping the short end always pointed toward the motive power. As it is dragged ahead, the prunings collect under the chain or rope but above the point of the pole. After the first few prunings are caught a very clean job of removal for the remainder of the row is done. One trip per middle is sufficient unless the rows are so long or the prunings so heavy that the initial collection must begin elsewhere than at one end of the row. The load is very easily

dumped at any desired point simply by lifting the rear end of the gin pole, thus permitting this end of the pole to be pulled upward and forward and thereby eliminating the collection angle between the pole and chain. The rope, cable or chain must be long enough to permit the upending of the pole with no risk of its hitting the driver.

Tying . The grape attaches itself to its support by the twining tendrils which develop opposite many of the leaves on new growth. In the pruning process many if not all such connections are broken, so there is nothing to hold the canes in position. Tying them becomes necessary. Tying should be done after the prunings have been removed but before any growth is made. The new shoots with their potential fruit clusters are easily broken from the cane and hence must not be roughly handled after growth begins. Very shortly the new tendrils begin twining around the trellis wires. Thus the need for tying is only temporary. Short lengths of a soft twine such as that used by millers for sewing sacks are very satisfactory and easy to use. Twine or cord with a hard finish often causes blisters on the tier's hands. Florist's raffia will also do if it is kept wet until it is tied. The latest material to be recommended is a rubber band so constructed that by a knob and notch arrangement sufficient pressure is developed to hold the cane in position without a knot. Wire ties or even strong cord should never be used and the canes should not be held too closely against the wires or other support, or partial girdling will occur.

An attempt should be made to hold the trunk upright and then distribute the canes over the trellis if the Kniffin training system is used. With the fan system only the distribution of the canes in a fan-shaped pattern is of consequence. Generally the longer canes are on the outside borders of such an arrangement.

Twisting the canes around the wire may be effective in holding the plant in place until new tendrils form but will cause much difficulty in the removal of prunings at the next pruning period. Bunching the canes in tying causes concentration of the clusters, and therefore is undesirable from the harvesting viewpoint.

The trellis . The grape vine must have some support - otherwise it sprawls on the ground and the clusters are of little value because of their soil contacts. Anything from a post for each plant to an elaborate wooden trellis will serve. Probably the most satisfactory trellis for the commercial vineyard is a post and wire arrangement with the lower wire being 2 to 2 1/2 feet from the ground and the top one 4 to 4 1/2 feet. Either a two-wire or three-wire trellis works well. The two-wire trellis is cheaper to construct, but the three-wire trellis allows a better distribution of the fruiting parts. A higher trellis can be used in an area sheltered from summer winds. No. 10 galvanized wire is usually heavy enough for the purpose. Posts are placed midway between each second and third, or each third and fourth vine. Closer spacing is required with very vigorous varieties or when light posts are used. If steel posts are used, heavy stay posts are required at intervals.

A plan frequently used when wooden posts are available is to staple the upper wire loosely to the top of the post. The posts must be set at a uniform height. The second wire - and the third if used - may be stapled loosely to the post or placed in a downward slanting slit sawed in the uphill side of the post. The mouth of the slit is then stapled shut. If steel posts are used the trellis wires are fastened to them at proper levels by various means. The wires should be kept reasonably tight but should be fastened permanently only at the end posts. End posts may be held in position through the use of a "deadman" or by proper bracing. Trellis maintenance is more difficult on contoured rows.

The trellis should be in place not later than the beginning of the second growing season and sometimes the lower wire is useful the first season.

Winter protection . In the eastern third of the state, the commonly planted varieties such as Concord, Worden, Diamond and Brighton survive the average winter without protection. Tender varieties such as Delaware and Caco are benefited by having protection from the drying northwestern winter winds even in the southeastern counties. The *vinifera* types such as Tokay, Golden Muscat and Black Hamburg have been wintered successfully by some eastern Nebraska growers by laying down the vines and covering them with 3 or 4 inches of soil. Some winter damage will be found on the late growing parts of nearly all varieties but unless the injury extends back into the cane portions desired for fruiting purposes, no real harm is done. Unpruned plants with their abundance of weak growths show more winter damage than healthy, vigorous plants since the thin, weak canes are more easily killed than the thicker more vigorous ones.

In the central and western parts of the state it is essential that most varieties be protected against the drying effects of winter winds. The plants should be pruned, bent over, pegged down if necessary and then covered with soil. The entire plant, trunk as well as canes, must be covered. If irrigation is possible the soil should be thoroughly soaked before being frozen solid. Vines protected as suggested must be uncovered and tied to the trellis just before bud growth starts in the spring, since swollen buds are very easily broken off. The uncovering date will be delayed a few days if the vineyard is straw-mulched. The mulch reflects some of the sun's heat, thus preventing the ground from warming up quite so early.

A winter windbreak for the vineyard, especially in exposed locations, is always desirable. Where no protection is available, bundles of corn fodder may be placed against the fence - or even the trellis wires of the outside row - on the north and west sides of the planting.

Insects and Diseases

The application of protective sprays may or may not be essential for home vineyards. However, if disease and insect damage is to be held to the minimum, several spray applications may be necessary, particularly in wet seasons.

Another effective way of protecting grapes from birds as well as from disease is to bag the individual clusters shortly after the fruits have set. A manila paper bag of the proper size is opened, pulled up over the cluster, and the top then pinned or fastened with a paper clip around the cluster stem. A small opening in the bottom of the sack insures drainage. Not only are the clusters protected but the fruits retain the waxy covering or "bloom" in good shape. The fruits develop full color although no direct sunshine reaches them.

The spray materials now usually recommended for use on grapes are **Ferbam** and 50 per cent wettable **DDT**. These are used at the rate of 1 pound of each per 50 gallons of water (5 teaspoonfuls **Ferbamate** and 2 tablespoonfuls **DDT** per gallon). **DDT** is quite effective in grape leafhopper control but **Ferbam** does not control downy mildew.

Another good combination which has been used extensively in the past is **Bordeaux mixture** and **arsenate of lead**. The arsenate does not control the leafhopper, however, and **Bordeaux**, while controlling mildew in good shape, may cause some foliage damage. If the leafhopper is a serious pest, nicotine sulfate (**Blackleaf 40**) should be added to this combination at the rate of 1/2 pint per 50 gallons (1 teaspoonful per gallon). **Bordeaux 4-4-50** plus 1 1/2 pounds of lead arsenate may be made up in small quantities by mixing 8 level teaspoonfuls of fresh hydrated lime, 3 teaspoonfuls of immediately soluble copper and 4 rounded teaspoonfuls of lead arsenate in a gallon of water. Ready-mixed dry **Bordeaux** is also available. Full directions for its use are printed on the package.

Seldom are more than three spray applications necessary in Nebraska unless some particular disease or insect becomes especially troublesome. The applications are given at approximately two-week intervals. The first one is applied just before bloom, the second just after bloom and the third 10 to 14 days later. In dry seasons the fungicide (**Ferbam** or **Bordeaux**) may not be needed but practically always an insecticide is required to control the leafhopper. In very wet seasons a fourth or even a fifth application may be necessary to keep disease under control.

Brief descriptions of the more common grape insect pests and diseases and suggestions for their control are given below.

Grape flea beetle - small, shiny bluish-green beetle which often drops to the ground if disturbed - destroys the swelling or opening buds. Control: Lead arsenate 2 pounds per 50 gallons (2 table-spoonfuls per gallon) applied just as buds begin to swell and again 10 days later. **DDT** sprays or dusts are also effective.

Grape leafhopper - often known as "thrips" - a small whitish sucking insect with only the adults being winged - conspicuous late in the season. Badly mottled or yellowed leaves drop and fruits do not mature properly. Control: DDT spray or dust (5%) or a nicotine sulfate spray is applied to the lower leaf surfaces in early July before the winged forms appear. If nicotine sulfate is used, 2 pounds of soap per 50 gallons of spray will improve the wetting qualities of the solution.

Grape root worm - larva does great damage to small roots and rootlets. Adults feed on the leaves in June and produce their characteristic chain-like punctures. Control: Arsenate of lead or DDT as soon as the punctures are noticed. The addition of 1 gallon of cheap molasses per 50 gallons of spray makes the material more effective.

Leaf eating insects such as rose-chaffer, eight-spotted forester moth, grape curculio, etc., are held in check by applying either of the suggested insecticides as soon as the damage is noticed.

Grape berry moth - developing larvae feed on young fruits, often destroying the cluster through the webbing together of the fruits. Control: DDT or lead arsenate just after the blossoms fall and again three to four weeks later.

Grape cane borer - a small brownish beetle which burrows into a cane at or near a bud, causing all new shoots beyond that point to wilt - worse near wooded areas and in neglected vineyards. Control: Destruction of all infested canes and prunings by burning as soon as possible.

Grape phylloxera - an aphid or louse feeding on the roots - winged adults in summer deposit eggs in the leaf tissue, causing later development of warts or gall-like formations on the lower leaf surfaces. More frequently found on Beta than any other common variety. Control: Avoid susceptible varieties.

Black rot - a fungus trouble causing spots on leaves, stems, tendrils and fruits - may destroy most of the crop in wet seasons, since the affected berries soften, turn brown and then shrivel. Control: Ferbam or Bordeaux applied at two-week intervals beginning just before the blossoms open. Ferbam, according to some recent reports, was effective even though thorough spray coverage was lacking.

Downy mildew - affects all succulent parts of the plant - appears as grayish-white spots on under side of the leaves. Usually found in low places and in very wet seasons. Control: Bordeaux at two-week intervals as needed. Good air circulation in the vineyard is also very helpful since it helps to keep the leaf surfaces dry.

Harvesting Operations

Grapes color before they are thoroughly ripened, so color is not a reliable guide by which to judge maturity. Immature grapes are low in sugar content and of poor quality generally. Since sugar formation ceases when the cluster is severed from the vine, grape quality does not improve after harvest as is the case with the apple and pear. If fully flavored grapes are desired they must remain on the vine until fully matured. Maturity is indicated by a slight shriveling of the cluster stem, by brown seed coat color, by the greater ease with which pulp and seeds may be separated and by a decided softening of the pulp. Flavor, of course, is the final test.

The use to be made of the fruit determines to some degree the time of picking. Many jelly makers prefer only partially ripened fruit for that purpose since jelly can be produced with greater ease and certainty because of the higher pectin content. Fine jelly can be made from fully ripened fruit, but there is a greater tendency for sugar crystals to develop in the finished product unless care is exercised in the processing. For table use and particularly for grape juice the higher sugar content of the fully matured fruit is a necessity. The longer they remain on the vine the sweeter the berries become.

Grapes are harvested by cutting the cluster stem with shears or a knife. An expert harvester is often able to detach the ripened cluster by giving the stem a sharp pull at right angles to the direction of the fruiting stem. In all cases care must be used to avoid squeezing the fruit or dropping it into the container. The latter action causes many berries to be broken from the cluster because stems and pedicels are very turgid or brittle. Shallow baskets or trays are most desirable for picking containers. Picked fruit should be taken at once to a shelter or at least placed where it is not in direct sunshine.

Packing . The commercial container used by grape growers in marketing their products is the 4-quart Climax basket holding about 5 pounds of fruit. Since the berries are soft and crush easily, containers larger than the 12-quart Climax basket or the half-bushel lug (20 pounds) are seldom used. Immature grapes to be sold for jelly purposes are sometimes marketed in bushel baskets, but this package is too large. At roadside fruit stands containers of various other types may also be found.

For home use the fruit will be harvested at the maturity stage desired and no grading will be done. If surplus fruit is to be sold on any basis other than "vine run" it will have to be graded. The smaller, straggly bunches, clusters with diseased or deformed berries, and clusters with green or partially ripened fruit are taken out. Only the large, well formed, well ripened clusters are used for basket grapes. If the grapes are permitted to wilt somewhat before being packed they will stand this handling with less shattering.

Grapes may be held in cold storage for several weeks if they are well matured and properly packed. Most immature berries will probably fall off the bunch in storage. American varieties, under no circumstances, have the keeping qualities of the Old World varieties.