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GRAPE CULTURE

With better marketing facilities, increasing local consumption and more satisfactory returns on both local sales and shipments to distant markets, keener interest is being taken in the production and marketing of grapes. The demand for information on this subject warrants this publication. Numerous varieties suitable for table use, the manufacture of wine, and the production of raisins, grown under favorable conditions of soil, irrigation and management! have given evidence of the adaptability of several very desirable grapes to the Southwest. Humid air and frequent showers during the ripening and drying of raisin-grapes makes the production of raisins uncertain, and oftentimes unprofitable. Recent legislation has apparently terminated the manufacture of wine within the State. The grapes, therefore, that will prove profitable are the table or dessert varieties.

NURSERY STOCK

Three very important points requiring a definite decision before purchasing stock are, first, the class of grapes desirable for the locality; second, varieties adapted to the local conditions, and third, the kind of stock,

Class:—Representatives of the two large classes of grapes, namely, the American and European, occur throughout the State. The European grapes, many of which are well adapted to conditions existing at elevations below 3000 feet, include varieties of commercial importance. American grapes, a few of which are grown quite successfully at low elevations, show a greater range of adaptability, giving fairly satisfactory results, especially under more favorable conditions, at elevations of 5000 to 6000 feet, or over.

Varieties:—Thompson's Seedless has proved to be our best early market grape and can be shipped to distant markets with satisfactory financial returns. The Almeria, Muscat, Black Hamburg, Purple Damascus, Mission and Zinfandel are also grown with good success, provided there is good management, and control of the leaf-hopper. The *Bowood* Muscat, Jura Muscat, and other less well-known forms of European grapes are in some respects as promising as some of the well-known ones.

At elevations below 2500 feet the berries of the black fruited American varieties, including the Concord, mature very unevenly in

the bunches and are less desirable than the red fruited sorts such as the Catawba, Agawam and Jefferson, or the green fruited sorts of which the Niagara is chief. Hot days and cold nights, in the more elevated and less exposed places, produce very similar, but more marked results.

Kind of stock:—There is a vast difference in the resistance of the American and European stocks to the attacks of the *Phylloxera*, which is the most destructive pest of the grape. It has in the past destroyed the vineyards of Europe and Algiers and has killed out thousands of acres of vines in California. It is, therefore, advisable to plant the resistant American stocks grafted to the desired European varieties, notwithstanding the higher price of the grafted stock for planting and the greater cost of the care of the vineyard thereafter.

SOIL, PLANTING AND CULTURE

Selecting a soil: While grapes will grow satisfactorily in almost any type of soil, if given proper management, the type best suited for grape culture is one permitting deep penetration and an unrestricted spread of the rootlets. The ground should be strong enough to produce without the addition of a fertilizer. Soluble salts should not occur in excess, although the vine will endure large proportions of alkali.

The deep rooting of grape vines is absolutely essential to long lived plants and the production of large yields of excellent fruit. In irrigated sections, where rainfall does not occur during the growing season, the depth of root penetration is determined by the abundance and location of the moisture. Loose, open soils, wetting easily to a good depth, permit deep penetration of the soil-mass with feeding roots. Vines in such soils make vigorous top growth, with corresponding well developed stems and spurs, and are capable, if properly pruned, of bearing enormous crops of well developed fruit of desirable quality. Compact soils, carrying large percentages of moisture near the surface and none below, cause the plants to become shallow rooted. The mineral food supply is consequently limited and the roots are subjected to extreme and rapid changes of temperature and moisture. Such plants produce inferior fruit, the yield during season varies greatly, the producing lifetime of the plant is short, and the vineyard is likely to result in financial loss. The selection of the right type of soil is therefore very essential to success.

Preparing the soil: A well prepared soil is essential to the best results. The ground should be cleared of all surface rock, roots and other rubbish that would prevent working the soil to a depth of 12 to 16 inches. In most sections thorough tillage requires thorough irrigation before plowing and in conjunction with subsequent cultivation.

In handling a soil which will not absorb water readily and to a good depth, care must be taken to wet thoroughly and deeply before planting. It should also be borne in mind that at each subsequent irrigation the surface soil should not carry an excess of moisture, a

condition that encourages shallow rooting. The application of water must also be at intervals of sufficient length to keep the soil uniformly moist to a good depth, and yet sufficiently dry to induce deep rooting.

Laying out of the field: Following thorough preparation of the soil, the corner of the vineyard should be located and the first row run parallel with an established irrigation canal, a roadway, an orchard or some other permanent planting. Stakes may then be set locating the remainder of the rows and the hills in each row. This work should receive the closest attention so that the plants may be in perfect alignment both lengthwise and crosswise of the field. Rows 8 to 10 feet, apart and hills 6 to 8 feet apart, give sufficient space for the production of the table grape. Rows planted east to west and 10 to 12 feet apart, with hills 6 to 8 feet apart provide more suitable space for the production of raisins. In fields of considerable size the establishment of driveways is important. A section of 20 to 24 rows wide and about 40 to 50 hills long makes the removal of prunings and fruit, as well as other work, less expensive and laborious.

Number of plants to the acre: To determine the number of plants needed for a definite area divide the number of square feet in an acre (43,560) by the product of the distance between the rows and the distance between the hills and multiply by the number of acres.

Planting of cuttings: Cuttings vary in length from 8 to 18 inches. Eight to ten inch lengths are best for planting in the nursery; while 12 to 18 inch cuttings are more desirable for field planting, except where the soils are dry, when a 16 to 18 inch cutting is preferable.

Numerous methods are followed in the planting of cuttings. Any method that permits packing of the soil around the lower end of the cuttings will give the desired results. In setting, the second bud should be level with the ground. To prepare cuttings the lower end is removed just below a bud and the top about one inch above a bud.

Planting rooted vines: Prepare the vines for planting by trimming the top to a single cane cut back to two buds in length. Also shorten the roots to $\frac{1}{2}$ to 6 inches, depending upon the method of planting that is to be followed. The roots must be shortened so that they will not double up when planted. Setting with a dibble necessitates shortening to 1 inch or less, while planting in large holes by hand permits spreading of the smaller roots. These vines are set with two buds above the ground.

Planting bench-grafted vines: The pruning of bench-grafted vines is the same as just described except all roots above or near the union, and all canes near or below the union must be removed. These grafts are set with the union one inch above the ground and are then **hilled-up** covering the union.

Irrigating the vineyard: After the soil has been thoroughly tilled and irrigated to a depth of several feet and the plants set, accurate observations must be made on moisture content and depth. The irrigator, with the use of the soil auger, may determine with accuracy the depth and approximate amount of moisture present.

To force deep rooting the moisture must be controlled during the first two or three seasons. During the first season, however, the plants require closest attention. An occasional deep, thorough irrigation will secure the desired results.

After the vineyard has begun to bear, the influence of late irrigation on the size of the crop and quality of the fruit must be studied closely. Late irrigation produces a larger yield but lowers the quality of the fruit. With sufficient moisture in the soil during the early part of the season to permit continuous growth and development, the last irrigation may be given when the fruit begins to ripen. Water applied at this time should be sufficient to mature the crop and finish the vegetative growth for the season.

Staking: Unless the growth is unusually vigorous the first season, staking is not necessary until the following spring. Following the first winter pruning and before the buds start growth, set the stakes about 2 inches from the hill and on the side opposite to the general direction of the prevailing wind during the growing season. The stakes should be strong and long enough to support the plants, depending upon the system of training, whether short, half-long, or long pruned.

Short pruned plants are supported with stakes 2.5 to 3 feet in length when heading is to be done 10 to 12 and 15 to 18 inches from the ground. Long pruning requires a 5 foot stake and a low, one-wire trellis takes a 3 foot stake, while the two-wire trellis requires a 4 foot stake. The size of the stake varies from 1 to 2 inches square depending upon the length, and load to be carried. The depth to which they are driven depends upon the type of soil,—the looser the soil the deeper the stake must be driven. Redwood is perhaps the best lumber for this purpose. One must not fail to replace a support when a plant requires it. Any strong cord, twine or wire tied loosely around the vine will hold it in place.

PRUNING

General observations show that certain varieties do best when a definite system of pruning is followed. Many varieties of grapes, such as the Black Morocco, Muscat of Alexandria, Flame Tokay and Zinfandel, require short pruning to give the best results but other varieties, including Almeria, Dattier de Beirut, Cornichon, Emperor, Black Ferra and Malaga, produce more satisfactorily when pruned half-long; while Sultanina rosea, Seedless Sultana and Thompson's Seedless respond best to long pruning.

For a time in the development of the vineyard the pruning of all varieties is identical. Later, however, it becomes necessary to decide upon the system of training, whether vase-form, fan-shaped, vertical and bowed, vertical cordons or horizontal cordons. Since the vase-form, fan-shaped, and vertical and bowed systems are more commonly employed these are the ones described.

VASE-FORM PRUNING

The first summer pruning consists in removing suckers from the stocks," and the roots from the scions during July, and again in September. Following the pruning in July the plants are hilled-up with dry dirt to prevent root development, while later in the season the dirt is removed to allow hardening of the plants before freezing weather. The average for a young vine of one season's growth is 3 to 5 canes varying from 2 to 3 feet in length. Should it be necessary to stake the plants they should be handled as described under first winter pruning.

The first winter pruning should be done after the leaves have fallen in autumn and before growth begins in early spring. Remove all the canes except a well matured one with good, strong, well-formed eyes. Cut back this cane to a spur two buds in length. Also remove all surface roots within 4 inches of the surface. Do not fail to keep all roots cut from the scions thereafter. Do not allow the European variety grafted upon American stock to form its own root system, starve the resistant stock and become susceptible to the ravages of the Phylloxera. Staking the plants is essential at this time.

The second summer pruning must begin very early in the season. To develop a single, strong, vigorous, well ripened cane to form the permanent trunk of the vine, the stems are disbudded when the oldest of the young shoots is a few inches in length with the exception of two strong, well placed, low but upright shoots that will produce straight vines. When these shoots are 10 to 15 inches long, the stronger one should be tied to the stake, and the new buds or shoots that may have developed upon the disbudded portion of the stem should be removed. When these shoots are 2 to 2.5 feet in length they should be tied the second time. In case of developing the long-pruned vine a third tying later in the season is usually necessary. Should an unusually vigorous growth occur, topping must be done when the canes stand 12 to 18 inches above the end of the stake. Topping arrests the terminal growth and induces development of branches on a well matured cane with short internodes, which permits correct heading of the plant at a later time. This work must not be neglected as it is a most important practice in controlling the plants, regardless of whether the system of pruning is short, half-long, or long.

The second winter pruning consists in cutting the plant to a single cane at the height desired to form the head of the vine. This cane will consist of one and two-year-old wood. Only the buds on the upper half are allowed to grow. These buds produce the fruit and shoots to form the spurs left during the third winter pruning. A fairly heavy yield of fruit may be expected.

The third summer pruning should be done as soon as the buds and shoots begin to grow. Those below the middle should be removed and a little later in the season all suckers and shoots must be

removed at least once. Should the growth be unusually vigorous, pinching the vines at 18 to 24 inches is advisable.

Third winter pruning: If the pruning up to the time of the third winter pruning has been productive of correct results the plant consists of a straight, smooth stem bearing several well developed canes on the upper portion. At the time of pruning a sufficient number of spurs should be left to bear all the fruit buds the vine can utilize. A strong growing vine with numerous thick canes should bear a good crop. Such a plant at this age should carry 20 to 30 pounds of fruit. While pruning, a sufficient number of spurs and buds should be left to form the fruit bunches and new canes.

Before attempting the *fourth and subsequent winter prunings*, after the close of the growing season, the pruner must learn to distinguish between fruit-wood and sterile wood. Up to this time the development of the plant requires the selection of wood useful in forming the head of the plant. At this time a person should also have his ideal standard for the size of bunch, quality, and size and color of the berry for each variety to be pruned. The number and length of spurs necessary to produce the crop of fruit, new wood, and replacing spurs can only be determined by a close study of the yield and quality of the crop of the previous season and the number and size of the mature canes.

FAN-SHAPED PRUNING

The pruning done before the third winter pruning is precisely the same as for the vase-form. Since the fan-shaped vine requires a two-wire trellis the supports must be provided at this time.

To develop the head, only those spurs extending in the general direction of the row are retained. The top is cut back to two spurs, the number of eyes varying from two to six depending upon the size and vigor of the plant.

During the fourth and following winters the canes, which vary in number in proportion to the vigor of the plant, are cut back to about three feet in length. Great care should be taken to leave a spur at the base of each cane so that the plant will not be deficient in bearing wood at each succeeding season. Considerable skill is required to induce the development of new shoots near the head suitable to replace the bearing cane of the previous season.

VERTICAL AND BOWED CANES

Long pruning is employed in training the canes in a vertical and bowed position. The head is formed and maintained as described under fan-shaped pruning. Instead of a trellis a stake is set at each hill. If the canes are permitted to stand upright they are topped at about three feet from the ground and the tips tied loosely to the stake. To bow the canes the tips are bent toward the center and tied together firmly. Drawing the tips together in this manner spreads the canes apart giving good space for each cane.

THINNING FRUIT

Many varieties produce bunches of fruit that are too compact for handling and shipping. The removal of about one-third of the young berries by clipping when the fruit is one-third to one-half grown gives a more open bunch that may be handled to advantage and permits of better development of the fruit. Thinning is not very exacting work since it may be done in any portion of the bunch and with little reference to the size of the portion removed. Care in selecting portions to be removed, however, will give more satisfactory results.

INSECT PESTS AND DISEASES

Inspection of plants: There is a number of insect pests, and diseases caused by bacteria and fungi, that may be introduced on cuttings and plants shipped in from distant points. Since diseased plants cannot be cured and it is impossible to eradicate an insect pest without destroying all the plants, every attempt should be made to prevent the introduction of pests and diseases, the control of which may consume all the profits. All cuttings and plants, whether from a local nursery or from points outside the State, should be inspected by a competent person familiar with all classes of pests. The State maintains a corps of inspectors whose assistance may be secured by application to the Arizona Commission of Agriculture and Horticulture, Phoenix, Arizona.

PESTS AND DISEASES

The Phylloxera, leaf-hopper, black knot, or crown gall, and powdery mildew are the pests and diseases every grape grower should be able to recognize and control.

The Phylloxera, which occurs on our native wild grape, need not be seriously considered if resistant stock is used. Planting European varieties on their own stock is not recommended as infestation of a vineyard means total destruction.

The leaf-hopper sucks the juices from the leaves. Piercing of the tissues and removal of the juices cause the injured area to turn white or pale yellow. Badly damaged leaves turn yellow, then brown, and fall off. With the weakening and premature dropping of the foliage the fruit does not mature properly, and when infestation is serious, results in total loss.

The adults which pass the winter in the fields, attack the new leaves as soon as they appear in spring. Egg laying begins within a month and continues for about 6 days, after which time these individuals die. The eggs, which they deposit beneath the epidermis on the under side of the leaves, hatch and produce a second generation making its appearance late in May and early in June. This second brood begins to lay eggs in about five weeks and continues for 30 to 60 days. The two broods overlap, yet are distinct.

The pest is controlled by catching the over-wintering adults with screen cages and later thoroughly spraying the leaves before the nymphs form wings.

Prepare the spray by using one part of Black Leaf 40 to 800 parts of water and adding 2 pounds of soap to each 50 gallons of the Black Leaf mixture. Use a driving spray nozzle and drench the plants thoroughly.

Black knot is a disease, caused by a bacterium, which appears in the form of swellings or knots upon the trunk and branches of the vine. The disease usually causes severe injury to young plants and may render older ones unproductive. It occurs in practically all grape growing districts and may therefore be readily brought into a new territory through the introduction of cuttings or plants. Diseased plants cannot be cured, therefore the greatest care should be taken to plant healthy stock thereby securing a clean, healthy vineyard.

Powdery mildew: This disease is caused by a fungus appearing in two stages or forms,—the summer form and the winter form. The fungus lives on the outside of the plant forming a white powdery surface on the leaves, canes, flowers and fruit, and under the right conditions will destroy the entire crop of fruit and weaken the plants so that the following crops will be small and inferior in quality. The winter form, responsible for the appearance of the disease in the vineyard during the early period, may be held in check by thoroughly sulphuring the plants in spring when the young shoots are 6 to 18 inches in length. Cool moist weather occurring at a later date produces conditions favorable to the spread of the disease and necessitates one or more additional dustings. Sulphuring is only effective when a few days of warm weather follow the application of the sulphur.

Spraying with atomic sulphur at the rate of 10 to 12 pounds of sulphur to 100 gallons of water gives the desired results and also has the advantage of being effective at temperatures inhibiting the action of powdered sulphur. One thorough application of the atomic sulphur when the disease begins to appear will keep it in check unless rains occur making it advisable to apply a second spraying at once.

COMBINATION SPRAYING

During the past season the leaf-hopper has been extremely injurious, while the powdery mildew has become a serious pest on a few varieties. Since it is advisable to combat both the hopper and the mildew, the following combined insecticide and fungicide is suggested.

After catching the over-wintering leaf-hopper with a screen cage, spraying should be done just before the oldest of the first brood form wings. To prepare the spray add one part of Black Leaf 40 to 1000 parts of water and stir in atomic sulphur at the rate of 10 pounds to each 100 gallons of the diluted Black Leaf. Spray with sufficient pressure to force the solution into every crack and crevice of the plant and to thoroughly wet all the leaf-hoppers.

The plants may be sprayed again, if necessary, using the insecticide or fungicide or the combination.

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