Growing Wine Grapes in Maritime Western Washington

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Introduction

There are many unique features of growing wine grapes in western Washington, some of which also apply to the cool maritime climate areas of western Oregon and British Columbia. Heat units in this region can vary from about 1400 to 2300 growing degree days (GDD). In most of the areas, the weather is cool and fruit esters become concentrated, enhancing aroma and flavor in both the traditional cool-climate varieties such as Pinot Noir and the unique unusual varieties grown here.

Rainfall within the coastal region can vary from approximately 12 to 50 inches per year or higher. WSU's Northwestern Washington Research & Extension Center in Mount Vernon (NWREC) has recorded an annual 40-year average of 32 inches. Most of the precipitation in western Washington falls as rain in the late autumn to early spring, with occasional brief intervals of snow. Summers are relatively dry, particularly after the 4th of July. These climate conditions resemble those of some classic wine grape regions of Europe, such as Burgundy in France or the Ahr and Rhinehessen areas of southwestern Germany (Jackson and Schuster). This suggests that our area is also suitable for growing wine grapes of similar high quality. In addition, the variations that occur in mesoclimates due to different altitudes can be quite striking, from valley floor to 400'–700' elevation, and involve both unique soil types and wide variation in daytime temperatures. This results in creation of several unique and distinct appellations within a fairly small geographical boundary.

Since temperature can be a major limiting factor in cool-climate viticulture, accurate measurement of heat units at the vineyard or proposed vineyard site is important. Once that is determined, selection of varieties that are best suited to your mesoclimate enables you to concentrate on producing high quality wines. Grafting to the best adapted root-stock also improves vine performance with respect to vigor control, suitability to soil conditions, resistance to pests, and for advancing fruit ripeness compared with own-root plantings.

Getting Started: Site Selection and Preparation

When preparing to start a new vineyard in western Washington, do your homework properly to increase your chances for success. Site selection is very important. In locating your prospective vineyard, a south-sloping site is ideal to maximize your heat units. Very steep land should be avoided unless you plan to terrace. The soil must be well drained with full sunlight exposure. Grape plants do not tolerate poor drainage for long periods of time. Check with your local extension agency for a detailed soil map of your county. There are a wide range of soil types, and opinions differ as to what soil type is best and what geological type of parent material the soil comes from. This is often referred to as part of the *terroir* of a given site. If you already have a vineyard site selected, work to understand as much about your terroir as possible (Jackson and Schuster).

Generally, it is preferable to lay out rows in a north-south direction so that both sides of the vines receive similar amounts of sun. If there is a strong prevailing wind, rows should be at right angles to

the wind direction. If rows are parallel to the wind, the wind will travel down the rows and there is more likelihood of damage. Vineyards planted on slopes may have the rows going up and down, since this is thought to allow cold air to drain downslope more easily. Sometimes, however, it is more practical to let rows follow the land contour. In most vineyard layouts, some compromise among the various elements will be necessary, as few sites are ideally situated.

The next step is to take a soil sample (Fig.1). Remember that any sample is just a limited snapshot of the soil profile. The recommended sampling method is to take a 1/2-inch diameter soil probe and push it down into the soil about 12 to 16 inches. Put this sample into a bucket and repeat this process at several locations in that field. Mix the samples well, fill a soil sample bag, and send it to a reputable soil testing company. Most of the fertilizer companies will help you if advice is needed. If you have more than one soil type at your location, take a sample of each.

Fig. 1. *Use a 1/2-inch diameter probe to take a soil sample at several locations in each field.*

Some vineyard growers believe that starving your grapes can be beneficial and, to some extent, this is true when it comes to water management. However, you must provide the soil enough of all the essential elements to avoid problems with nutrition because it will affect the quality of the crop. In western Washington, soils tend to be high in organic matter, which usually releases more than an adequate supply of nitrogen, but other macro- and micronutrients can be limiting. Table 1 lists recommended guidelines for preferred levels of each element in the soil.

Hybrid and *V. vinifera* vines are apparently adapted to higher pH soils. A pH of approximately 6.0 to 6.5 for these cultivars is recommended (Throop, quoting Stiles). Low soil pH for wine grapes can adversely affect both vine health and juice quality. Increasing pH is often beneficial to row middle cover crop growth. This may be a result of increased availability of phosphorus. Limestone moves slowly into the soil—it may require one to two years or longer before effects of application are noticeable.

When the results of the soil test come back, follow recommendations for applying needed amendments, preferably incorporated into the soil before planting. However, in an established vineyard, amendments are applied on top of the soil. The ideal time to adjust soil nutrients is in the summer or fall before planting. Another option is to plant a cover crop to be worked in as a green manure.

Temperature is a very important factor in vineyard establishment. It influences the range of varieties that can be grown successfully (see Table 2), and the optimal layout of rows and trellises to take advantage of the specific mesoclimate. Minimum winter temperature is a factor in site selection also. Most areas in western Washington are not subject to winter temperatures that might damage grape vines, but some areas (higher elevations, exposed areas in the Fraser River drainage) could be a matter of concern.

To accurately measure temperatures, install a data logger that records accumulated growing degree days (GDD) at your site. It should run from April 1 to October 31. Heat summation refers to the

Table 1. Soil Fertility Guidelines (Stiles and Reid)

	Preplant	Established
Ca (calcium)	67% CEC	58% CEC
Mg (magnesium)	13% CEC	12% CEC
K (potassium)	200 ppm +	200 ppm +
P (phosphorus)	At least 40 lbs/Acre	At least 40 lbs/Acre
B (boron)	1–2 ppm	1–2 ppm
Zn (zinc)	2 ppm	2 ppm
Cu (copper)	2 ppm	2 ppm
Mn (manganese)	5 ppm	5 ppm

sum of the mean monthly temperature above 50°F for the period of concern (in grapes, from April 1 to October 31). The baseline is set at 50°F; little shoot growth occurs below this temperature. The summation is expressed as degree-days. For example, if the mean for a given day is 55°F, the summation is 5 heat units, and if the mean for June is 65°F, the summation is 450 GDD—15 degrees times 30 days in the month (Winkler, et al., *General Viticulture*, p.61).

The typical price of a data logger is around $200 (at time of this writing) but they are worth the investment. They will provide continual recording of temperatures at your site. This is a valuable tool in determining which varieties might be most suited to your vineyard. If your site has a combination of warm and cool areas (such as a south slope and a flat area), plant the later maturing varieties or clones in the warmer area. It is worth trying some later ripening varieties on an experimental basis even in the coolest locations.

Choosing the Right Varieties and Rootstocks

At the same time you are getting your site ready, you should be ordering plants. Order early to be sure to get the plants you want. Ordering a year ahead allows ample time for the nursery to get them grafted and growing. If you wait until the last minute, you might find that none are available, or that the clone you wanted is sold out. A very important decision is whether to plant own-root cuttings or grafted plants. If you decide on grafted plants, which rootstocks should you choose?

Starting in 2000, trials were conducted at NWREC with Pinot Noir 2A grafted on seven different root-stocks, with self-rooted plants for comparison. Based on three years of cumulative harvest data, our trials show that plants grafted on the rootstocks Millardet et de Grasset 101-14, Coudrec 3309 (also known as Couderc 3309), or Millardet et de Grasset 420A yield juice with significantly higher brix, lower titratable acid (TA), and higher pH than self-rooted vines. In other words, they mature faster and ripen more quickly over the same period (Moulton et al., 2002; Moulton et al., 2003; Moulton et al., 2004).

These rootstocks should be able to impose their characteristics of earlier maturation on other varieties that are grafted to them as well. Trials are in process to confirm this. In addition, wine sensory analysis has shown differences in tastes and flavors between wines of Pinot Noir 2A grafted on different rootstocks (Dr. Anne Noble, sensory evaluation workshop, June 2005). Preliminary observations indicate that Pinot Noir 2A showed enhanced characteristics of fruitiness and a desirable black pepper aroma, compared to wine from self-rooted plants.

Enhanced maturation is only one good reason for using grafted plants. These rootstocks were also selected for their resistance to infection by phylloxera as well as other problems such as nematodes. Most if not all of our current *vinifera* varieties will die if they become infected by phylloxera. Since it is present in nearly all grape growing areas, in all likelihood this could happen in your vineyard one day. Therefore, the extra investment in grafted plants will be a worthwhile insurance against potential future damage, as well as promoting higher quality fruit.

Be sure to purchase grafted plants from a reputable nursery that supplies plants certified as free of virus and phylloxera. If you are offered cuttings from an existing vineyard, this might seem to be a cheaper way to get started, but **BE AWARE THAT YOU INHERIT THE PROBLEMS** of the plant the cuttings were taken from (phylloxera, viruses, incorrect labeling or other problems) and they will be with you for the life of the plant. Furthermore, own- rooted plants will not have the additional benefits that rootstocks can offer. Again, it is strongly recommended that you plant certified plants grafted on one of the three rootstocks noted above. Purchase from a reputable nursery and order early. The Northwest Grape Foundation Service at Prosser is one source for obtaining virus-indexed varieties.

The choice of a rootstock for a particular location depends on the complex interactions between soil type, depth, physical and chemical properties, pests, diseases, water availability, and environmental factors, thus on-site evaluation is imperative. New rootstocks that have been bred for greater tolerance of acidic soils and other special qualities are in the process of introduction. Three of these that might be worth a trial evaluation are:

- Gravesac, result of a complex cross originating in Bordeaux from several North American *Vitis* species, tolerant of acid soils
- Schwartzmann, a heavy fruiting stock of low vigor similar in character to Millardet et de Grasset 101-14
- 161-49 Coudrec, a low-vigor stock that resulted from crosses of *V. berlandieri* x *V. riparia*

Selected Varieties

(earliest varieties listed first under each category)

Information on varietal characteristics is from observations and data taken in test plots at NWREC since trials began in 2000. Some of the recommendations are provisional, based on limited observations. This list is not all-inclusive; several varieties may be worth a limited trial, but be conservative if you have no experience with a particular variety.

I. White Wine Varietals

GERMAN:

- **Siegerrebe**—(Madeleine Angevine x Gewurztraminer) (Fig. 2). One of the earliest varieties to ripen, the grapes look and taste similar to Gewurztraminer. This variety makes an excellent fruity wine with spice and litchi fruit aromas. It has been grown in western Washington for about 25 years and is a signature white that every vineyard should have.
- **Ortega**—(Muller-Thurgau x Siegerrebe) Grown mainly on Vancouver Island for many years, this variety makes a light, pleasant, fruity wine and is very productive.

  Other German whites that show promise are **Ehrenfelser, Kerner [Kernling], Optima, Red Traminer,** and **Sylvaner**. **Muller-Thurgau** is found in many western Washington and British Columbia vineyards but some of these newer varieties are of higher quality and/or ripen earlier.

FRENCH:

- **Madeleine Angevine**—(Madeleine Royale x Precoce de Malingre) This variety makes a good fruity white wine with citrus aromas and a note of apricots, and has been grown in western WA for about 25 years. It is productive but susceptible to water stress and fruit rot.
- **Pinot Gris**—(Pinot Meunier x Traminer) Make sure to select an early clone (e.g., Ruhlander, or Alsace clones 152 and 146.) Pinot Gris is usually not as productive as some varieties but makes a great white fruity spicy wine. Be sure the plants are grafted to one of the recommended rootstocks.

Fig. 2. *Siegerrebe is one of the earliest ripening varieties.*

- **Chardonnay 76**—This clone is significantly earlier than regular Chardonnay. The clusters are smaller and vines are less productive, but it makes a good Chardonnay wine; it should be grafted on recommended rootstock.
- **Sauvignon Blanc**—This has great potential, particularly on warmer sites. Find the earliest clones and put them on rootstocks.
- **Auxerrois Blanc** is another promising white variety, originating in the Alsace region of France, that is worth trying in this area.

OTHER PROMISING VARIETALS:

- **Burmunk**—Of Armenian origin, this variety has a distinctive aroma, very fruity, sometimes resembling fresh-sliced peaches. One of the earliest grapes, it will ripen at almost all sites.
- **Iskorka**—Originating in Russia (the name means "sparkle"), it makes an extremely fruity wine with orange and honeysuckle notes, also a very early grape that will ripen at most sites (Fig. 3).

II. Red Wine Varietals

GERMAN:

- **Regent**—[(Sylvaner x Muller-Thurgau) x Chambourcin] This grape has 1/8 hybrid ancestry but tastes like a vinifera. The vine is very disease resistant and bunches form loose clusters, a very good red for the organic grower and home winemaker.
- **Dunkelfelder**—(derived from Portugieser and Färbertraube varieties) A teinturier grape with very red juice, acid levels at harvest tend to stay high while reaching high sugar levels. Initial

Fig. 3. *Ortega is another early ripening variety.*

observations indicate it would probably be best to blend with Dornfelder.

- **Dornfelder**—(Helfensteiner x Heroldrebe) The vine is vigorous and makes very large, loose open clusters. It can over-produce and may need cluster thinning. Good resistance to rot has been observed. Sugar levels tend to be low but acid levels also drop fast prior to harvest. It may benefit from blending, particularly with Dunkelfelder.

FRENCH:

- **Pinot Noir Precoce**—Also known in Germany as Fruheburgunder (Fig. 4). Berries develop color at least two weeks ahead of regular Pinot Noir. This variety looks promising, particularly for very cool sites.

- **Pinot Noir**—Select a mix of early clones, such as 777, 667, and 115, that have smaller clusters and lower productivity. Many sites have great potential to make Burgundian type Pinots. Make sure they are on recommended rootstocks.

Fig. 4. *Pinot Noir Precoce is a promising variety for very cool sites.*

AUSTRIAN:

- **Zweigeltrebe**—(Limberger x St. Laurent) This grape makes an excellent fruity Pinot type wine, with great potential for cool climate areas like ours. Tight, large clusters require diligent botrytis control and will benefit from cluster thinning. Good canopy management techniques will get the most out of this variety. It should be grafted on recommended rootstock.

HUNGARIAN:

- **Agria (Turan)**—[(Teinturier x Kadarka) x (Medoc x Csabagyongye)] This variety looks very promising for our area, a tenturier with bright red juice (Fig. 5). The skins have high tannins. This variety offers possibilities for several styles of wine making. When crushed and pressed immediately then fermented like a white, the juice is still dark red but the wine is extremely fruity, with berry and tropical fruit aromas, and exhibits some characteristics of a Gamay Nouveau.

Fig. 5. *Agria is a teinturier grape with red juice.*

OTHER VARIETIES:

- **Golubok**—Russian origin (the name means "little pigeon," a term of endearment), a very early teinturier with a lot of potential for a unique full-bodied red wine.
- **Garanoir**—(Gamay Noir x Reichensteiner) This variety is of Swiss origin and is a very early red, one of the first to ripen. Its juice does not attain very high sugar levels, but acid levels drop quickly as the fruit ripens. It will probably do best when blended with Gamaret (below), another Swiss cultivar that retains higher acids but also higher sugars.
- **Gamaret**—This is a Pinot type of Swiss origin with good quality and more body than Pinot Noir, probably best mixed with Garanoir.
- **Rondo**—(Saperavi Severnyi x St. Laurent) This German red is new to the trial but first fruits on young vines are very early. The vine is reportedly winter hardy and of great interest in cool climate areas.
- **Leon Millot**—A French-American hybrid still grown in area vineyards, this variety is disease resistant and should be considered for home growers, though its wine quality is only fair.
- **Norwegian Muscat**—This is a very early Muscat red grape with unique flavor.

GENERAL VARIETY RECOMMENDATIONS

Results of the trials to date have clearly shown that high quality wine grapes can be grown in western Washington, given careful choice of the appropriate varieties and rootstocks, good cultural practices, and selection of a proper site. These recommended varieties should benefit from being grafted onto a rootstock (preferably Millardet et de Grasset 101-14, Couderc 3309, or Millardet et de Grasset 420A).

Use the recommendations in Table 2 as a guideline for varieties to plant. If your site is on the borderline (e.g., 1800 GDD), you may want to experiment with varieties that are listed for the warmer area (above 1900 GDD). For example, if your site registers 1650

Table 2. Variety guidelines according to Growing Degree Days

Under 1600 GDD	1600–1900 GDD	Above 1900 GDD
Siegerrebe (W) Pinot Noir Precoce (R) Garanoir (R) Leon Millot (R) Muscat of Norway (R) *When available:* Rondo (R) Burmunk (W) Iskorka (W)	*Everything listed at left, plus* Pinot Noir cl. 667 (R) Pinot Noir cl. 777 (R) Pinot Noir cl. 115 (R) Agria (R) Regent (R) Zweigelt-rebe (R) Marechal Foch (R) St. Laurent (R) Pinot Gris [Ruhlander] (W) Madeleine Angevine (W) Ortega (W) Optima (W) Sylvaner (W) Auxerrois Blanc (W) *When available:* Golubok (R)	*Everything listed at left, plus* Pinot Noir [all clones] (R) Dornfelder (R) Dunkelfelder (R) Gamaret (R) Chardonnay cl. 76 (W) Sauvignon Blanc (W) Kerner [Kernling] (W) Red Traminer (W)

GDD, you may want to concentrate mainly on varieties in the first column, and be more cautious about planting those in the middle column.

Regent is particularly recommended for home growers who are interested in red wine making. It is very productive, with potential for making a high quality wine, and the plants show good resistance to disease. Other hybrids with disease resistance are Leon Millot and Marechal Foch. Adopting certain cultural practices can do much to enhance fruit maturity and make disease control easier. Fruit quality will be maximized by cluster thinning, good canopy management, and attention to nutrition and disease sprays, applied to an open canopy in a timely manner.

Row and Vine Spacing

After selecting varieties, your next decision is the row and vine spacing. It is helpful to select a training system as early as possible since this will affect the spacing. Optimizing fruit quality involves getting sufficient sunlight to the leaf canopy and balancing leaf growth with fruit production. In-row spacing ranges from 4 to 8 feet, depending on site vigor, with 5 to 6 feet as a good compromise. Space between rows can be as close as the height of the trellis in a 1:1 ratio.

If using a vertical shoot positioning method of training (VSP, Fig. 6), with the fruiting wire at approximately 30" above ground level, allow about 4 feet of canopy above the fruit to mature your clusters (about 14 leaves per shoot). Therefore, a canopy height of about 6.5 feet, with row width in proportion, is the closest row spacing that is practical. In addition, you have to allow proper clearance for equipment between these rows. Remember that placing the rows closer together will increase your yield per acre.

Another way to increase yield and still maintain quality is to use one of the divided canopy systems, discussed in *Sunlight into Wine* (Smart and Robinson, 1991). Trials show that the Scott Henry system and variations of it, such as Smart-Dyson, can reduce vigor and increase yield significantly (due to the increase in number of total buds per plant), while maintaining good fruit quality (Fig.7). Most of these systems can be converted from a VSP system.

For trial purposes, you might want to plant a row of the divided canopy system to evaluate it for ease of management and economic factors. Most vineyards in western Washington and Oregon and coastal British Columbia have used the VSP system. There are certain variations, but basically it involves developing a trunk that is 12 to 30 inches from the ground. Since grapes fruit on last year's growth, new canes are bent down from the top of the trunk to a fruiting wire each year.

Theoretically, setting the fruiting wire low (about

Fig. 6. *Vertical shoot positioning is a common training system.*

Fig. 7. *Using a divided canopy system (e.g., Scott Henry) can increase yields.*

12" above ground level) utilizes heat from the ground to advance fruit maturation, particularly if the site is not windy. This depends to some degree on the soil type; a darker soil absorbs more radiation while lighter soil reflects it. However, harvesting the grapes on low wires becomes very challenging, requiring special harvest aids or a lot of stooping, which in turn can present labor problems. When the fruiting wire is 28 to 32 inches from the ground, harvest and canopy management become much easier.

As a baseline recommendation, start with a VSP system, spacing the vines 5 to 6 feet apart in the row and allowing 7 to 8 feet between the rows, provided that your equipment (sprayers, mower, etc.) will fit that spacing. Vines should be lined up straight in the row; this will help ease cultivation and cultural practices, particularly if rows are very closely spaced.

Trellis Structure

Trellis structure is usually constructed with well-anchored, heavy wood end posts. This allows the use of high-tensile wire that can be tightened firmly to support the weight of the vines in production. For interior support posts, use either smaller diameter wood posts or metal posts that are pre-notched to facilitate the raising of catch wires. This reduces the labor needed to keep the shoot canopy gathered into a narrow vertical wall for good light penetration. These posts are usually set 24 to 30 feet apart along the row. In addition, each plant normally has an individual stake (usually bamboo) set next to it at planting or shortly after. This stake is fastened to the fruiting wire and is used to train the trunk of the new plant. (See ***Further Information***, E-2645 [Zabadal] for engineering details of trellis construction.)

Irrigation

Irrigation is supplemental in western Washington **EXCEPT** in the young vineyard when vines are being established. Young, newly grafted plants are especially sensitive to drought and need ample regular watering to produce a vigorous root system in the first year. From experience in on-site trials, irrigated plants can be in full production by the third leaf, significantly advanced in comparison to a non-irrigated planting. Starting off a vineyard with strong vines that come into production earlier is worth the additional cost of installing irrigation. Also, irrigating a new vineyard tends to promote survival and growth in weaker plants and results in a more uniform vineyard when it begins to bear.

Many sites will not need irrigation in most years once the vines are well established. However, sites where the soil has low water-holding capacity will benefit from irrigation every year. Drip-line

irrigation is the preferred system, economical to install and very efficient in water usage. Lines can be left in place after the vineyard is established for use as needed in conditions of unusually long dry spells. If certain areas of the vineyard (e.g., sand streaks) tend to dry out more quickly, be sure to monitor the moisture levels carefully to prevent the plants in that area from developing water stress. Use of soil monitoring devices such as irrometers (tensiometers) is recommended.

At Planting Time

In most areas of western Washington, planting can be done in the dormant season, any time from December to April when the ground is workable. Newly grafted vines can be planted later, up until early June. However, irrigation is essential when establishing such new, actively growing vines. **Plant vines so that the graft union (the point where rootstock and scion variety are joined) is above the ground (preferably 4"–6") to prevent the scion variety from rooting** (Diagram A-1). Firm the soil around the new vine. To enhance soil warming, enable drainage, and help in water management, plants can be set on raised beds. The beds are raised after soil amendments are incorporated but before planting. Cut scion to two buds and place a stake (about 3' long) next to the vine (Fig. 8; Diagram A-2).

Vine Training—Year 1

As the new buds grow, select the dominant shoot and tie it to the stake. Grape plants are apically dominant; shoot growth is much stronger when shoots are positioned vertically.

Often the new trunk will need additional ties to keep it straight and growing vertical and parallel with the stake. This shoot will become the trunk of the future vine, so it should be kept as straight as possible. Other side shoots may grow strongly as well, competing with the selected trunk. Pinching off the shoot tip of competing shoots slows them down and re-directs more energy to the new trunk (Fig. 9; Diagram A-3), while still keeping plenty of leaves to add to carbohydrate accumulation and support plant growth. The objective is to get a new trunk to the fruiting wire in the first year after planting.

Fig. 8. *Cut back to two buds at planting.*

Fig. 9. *Pinching off competing shoots directs energy to the new trunk.*

Vine Training—Year 2

If the trunk growth is about 30 inches tall or more, a trellis should be installed. (Trellis installation can also be done during the first year, particularly if the trellis wire is also carrying the irrigation lines.) A horizontal wire is placed at about 28 to 32 inches, and the 3-foot vertical support stake is attached securely to the wire. The new trunk is attached to the stake so that it is straight. The new trunk is normally pruned back at about 3 to 4 inches below the wire (Diagram A-4). The top three to four buds on the trunk push new shoots; shoots emerging lower on the trunk should be removed (Diagram A-5). If the growth is vigorous, side wires will need to be added to the trellis posts. These new shoots will become fruiting canes the following year, and form the basic structure for vine renewal in succeeding years.

Vine Training—Year 3 and After

After the basic structure is established—a strong trunk with fruiting canes renewed annually at the level of the fruiting wire—then pruning and training follows systematically from year to year. Two fruiting canes will be bent down and attached to the fruiting wire, in opposite directions down the row (Diagram A-6 and B-1). The terminal ends of each of the canes should be bent below the wire to prevent the terminal bud from becoming too dominant. Sometimes a second wire is placed about 4 to 6 inches below the fruiting wire to attach the terminal tips so they remain pointed down. These terminal tips should touch the terminal tips of the adjacent vine at the halfway point between the vines, so that all available in-row space is filled with productive shoots.

New shoots originating from buds on last year's canes will start to grow. The new shoots will be contained and prevented from flopping down by using side trellis catch wires (Diagram B-2). Another shoot positioning method is to tie the vertical shoots to a top wire using a tape-stapler similar to those used for tying tomato plants.

In the dormant season after harvest, select two new fruiting canes from the shoots that grew in the summer (Diagram B-3). In selecting new fruiting canes, choose those that originate closest to the main trunk, and those that have closer spacing between the buds. Try to avoid "bull canes" that grew vigorously over the summer and have long spaces between buds. Since canes may crack when they are bent down to the wire, leave an extra cane "in reserve" on each side, in case the first choice breaks. These reserve canes should be headed back to a two-bud spur if not needed. Try to keep the head of the main trunk about 3 inches below the fruiting wire, cutting back to a lower cane if necessary. These will be the canes that produce the next year's shoots, and the cycle repeats again each year.

Canopy Management: Pruning Weights Help Define Balanced Crop Load

The balance of crop load to vine growth is based on a ratio of the crop yield to the weight of cane prunings. This can be calculated by comparing the weight of fruit from a given row or section at harvest with the weight of cane prunings taken from the same area the following winter. For good crop balance and proper vine size, aim for a ratio of fruit weight to pruning weight ranging between 4:1 and 10:1. An alternative method is to compare the weight of cane prunings per foot of row to known standard measurements, which lie in the range of 0.15 to 0.35 lb per foot.

When the ratio of fruit yield to pruning weight is less than 4:1, or the pruning weight per foot of vine is more than 0.35 lb, this is an indication that vines are under-cropped, and that there is excessive vine size for the allotted space. Suggested remedies are to select canes that have the best sun exposure, leave more buds, change to cane pruning if the vines are currently spur pruned, change to a divided canopy system such as Scott Henry or Smith-Dyson, reduce the input of soil moisture and fertilizer, or rogue out every other vine in the row.

When the ratio of fruit yield to pruning weight is greater than 10:1, or the pruning weight per foot of vine is less than 0.15 lb, this is an indication that

Diagram A

AT PLANTING
Plant vines so graft union of scion and rootstock is 4–6" above ground.
Cut back scion to 2 buds. ■

YEAR 1
Select dominant shoot.
Tie to stake.
Keep tied as straight as possible.
Pinch off tips of any shoots that compete with the new trunk. ■

YEAR 2
Head new trunk at 3" below wire.
Top 3–4 buds produce new shoots.
Remove shoots that emerge low on trunk. ■

YEAR 3 and after
Renew fruiting canes annually.
Terminal ends should be bent and fastened below the wire. ■
Training wire set 4–6" below fruiting wires.

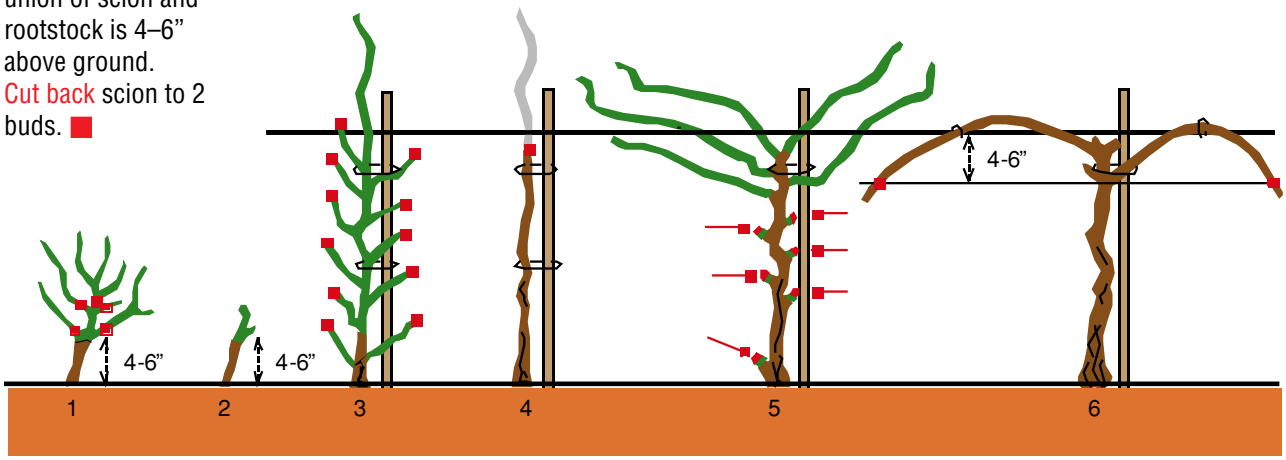
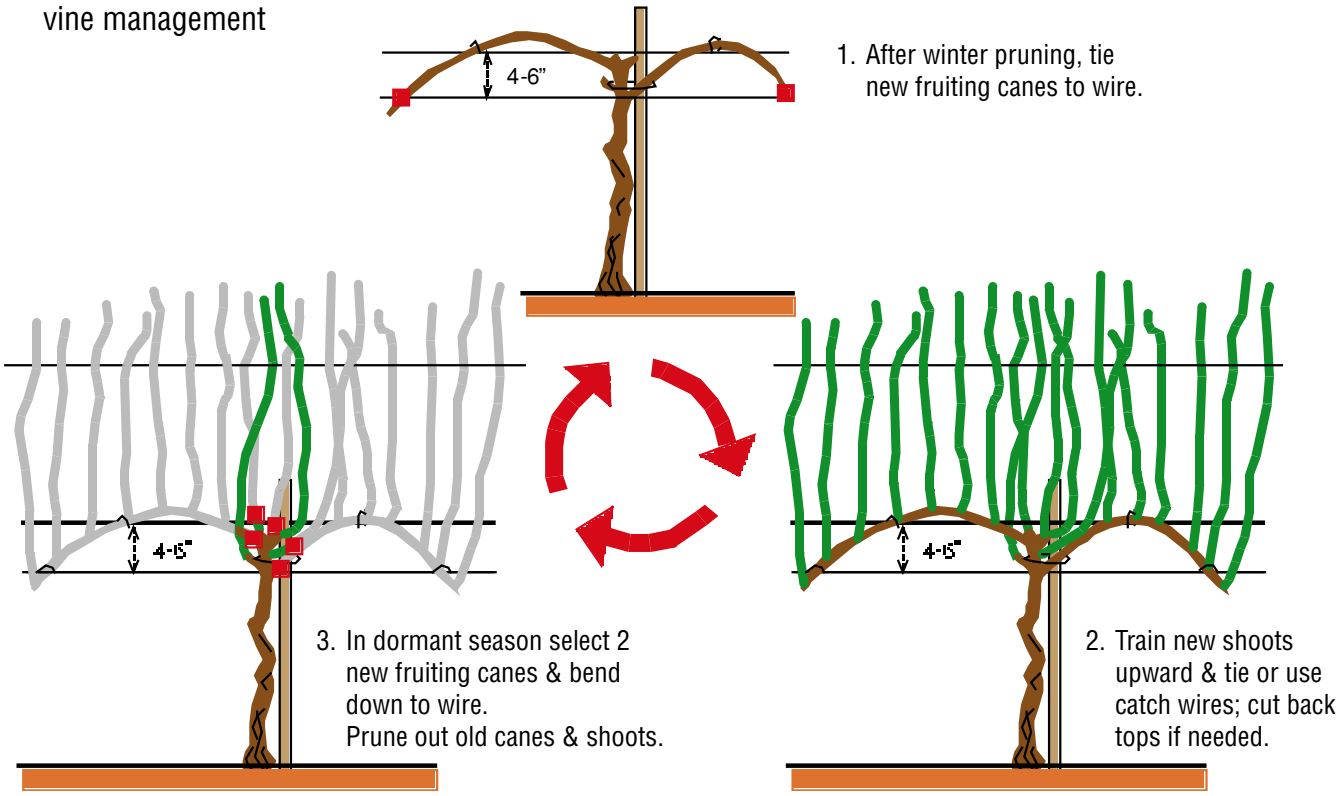


Diagram B—YEAR 3 and after

Repeating cycle of vine management



1. After winter pruning, tie new fruiting canes to wire.
2. Train new shoots upward & tie or use catch wires; cut back tops if needed.
3. In dormant season select 2 new fruiting canes & bend down to wire.
Prune out old canes & shoots.

vines are over-cropped and/or under-pruned, and that there is weak growth and low vine size for the allotted space. Suggested remedies are to leave fewer buds, change to spur pruning if currently cane pruned, increase fertilizer and irrigation, and prevent weed or grass competition (Lombard, *Oregon Winegrape Growers' Guide*, p. 144).

Canopy Management: Shoot Thinning and Spacing

Shoots should be thinned and spaced to allow good light penetration (Fig. 10). Thinning can be done after fruit set if vines are highly vigorous, or earlier if vigor is low. Shoot thinning is easier if shoots have not lignified. These new vertical shoots contain the grape cluster(s). Shoots with no flower clusters should be removed first. The leaves that develop on the same shoot as the fruit clusters are the primary source of carbohydrates to ripen those clusters. Approximately 12 to 14 well-exposed leaves per shoot are needed to support these grape clusters to full ripeness. It is very important to provide enough space (about 3"–4" between adjacent shoots) for each leaf on that shoot to receive sufficient light. Shoots should be kept in a tight narrow vertical trellis. This helps to facilitate good light exposure to each leaf.

The importance of light exposure is illustrated by the following example. If a leaf in full sunlight receives approximately 2000 microEinsteins (μE) of light, the light reaching a leaf underneath that first one is reduced by over 90%, down to about 120 μE; light reaching the third layer of leaves is reduced by a further 90%, to less than 7 μE, according to Smart (*Sunlight into Wine*, p.5). Since it is estimated that an exposure of 50 μE is needed for a leaf just to maintain its own respiratory functions, the third layer of leaves is actually contributing nothing to the ripening fruit. For greatest vine efficiency, keep the leaves well exposed and the canopy open.

Finally, good light exposure for leaves and buds are essential to develop the buds that form next year's crop. At pruning, when you select a renewal cane at the top of the trunk to set on the fruiting wire next year, choose one that has been well exposed to light so that it will be fruitful.

Canopy Management: Leaf and Cluster Thinning

Leaf thinning should take place around the grape clusters immediately after they have set fruit. Strip just the two or three leaves directly surrounding the clusters (Fig. 11). This will allow good access to the cluster for rot and nutrient sprays, aid in the quick drying of clusters to reduce disease, enhance light exposure and color development on the clusters, and accumulate the berries earlier. Finally, it helps facilitate berry sampling before harvest and picking

***Fig. 10**. Space shoots along the cane for good light exposure.*

Fig. 11. *Strip leaves around grape clusters to provide more light and air circulation.*

Fig. 12. *Uniform ripening can be improved by removing shoulders that are less mature.*

at harvest time. In our cool climate there are usually minimal problems with sunburn. However, in a hotter mesoclimate it may be better to remove leaves from the east side of the clusters only. Good canopy management is essential for good quality fruit.

Cluster thinning is a part of canopy management that can be done very early at veraison (fruit softening and color change of clusters). If done at veraison, one can leave two clusters per shoot on strong shoots (provided that they are maturing simultaneously) and one on moderately growing shoots. On weak shoots remove all clusters. The objective in cluster thinning is to have a uniform, well-balanced crop at maturity—neither over- nor under-cropped.

As discussed earlier, some idea of correct crop load can be estimated by pruning weights. In vigorous plantings it may be necessary to trim shoots above the top of the trellis to make it easier to spread netting (which will be necessary to protect the crop from birds as the grapes ripen).

Fine Tuning for Quality

Uniform ripeness in all the clusters from a particular variety or plot will improve the juice quality that results. Fine-tuning of the grape clusters can help to attain this. Cluster thinning, mentioned above, is one method. To further enhance fruit quality, the

greener clusters or parts of clusters can be removed at veraison when berries soften and begin to change color. Within a bunch, one section or "shoulder" may flower later than the rest of the grapes, and thus be less ripe at veraison. The shoulder area that is less ripe can be snipped out (Fig. 12). In the case of very high quality wines, sometimes even individual berries that are less ripe are thinned out by hand.

Removing these greener clusters and shoulders will improve the overall uniformity and quality of the juice. It also reduces the yield, so the grower will need to be compensated by higher prices for the wine produced. Quality and economic factors such as the labor and expertise to fine-tune the product must be calculated carefully to ensure a profitable result.

Nutrient Sprays

As the new shoots start growing and reach about 3" to 6" long, fruit clusters will be in the pre-bloom stage with caps still covering the flowers. Approximately two weeks before bloom, apply a boron and zinc nutrient spray. As the caps pop off and bloom begins, apply boron sprays accompanied by a fungicide for botrytis (see below). Two weeks after bloom, follow up with another boron and zinc spray (Throop, quoting Stiles).

Disease Control

The biggest problems in western Washington are powdery mildew and botrytis bunch rot.

Powdery mildew (*Erysiphe necator*)

Powdery mildew is a fungal disease common to all areas of the Pacific Northwest. The fungus may overwinter as a group of thin threads called hyphae, inside the vine's dormant buds and/or as small black bodies (cleistothecia) on the exfoliating bark of the vine. Buds on new shoots can be infected 4 to 6 weeks after shoots start growing. Start control early in the spring, as the fruiting canes start to push buds. The critical time for powdery mildew control is from the time that new shoots are about 3" to 6" long until after clusters set. Alternating your fungicide class types for control will aid in preventing buildup of resistance. (See ***Further Information***, below, for a list of bulletins on pest management.)

Botrytis (*Botrytis cinerea*)

Botrytis bunch rot is caused by a fungus that is very common in nature, and which causes diseases on a variety of unrelated crops. Bunch rot can cause serious losses in grapes. Wet weather favors disease development, especially near harvest when canopies are dense and berries accumulate sugar. The fungus can quickly spread from berry to berry within ripening bunches and can develop readily on wounded or split berries. Some varieties are more susceptible than others due to factors such as skin thickness and cluster structure.

Apply botrytis spray before and during bloom, after set and before berry clusters close. If possible, use an airblast sprayer to blow out any flower debris that may remain in the cluster between the berries. This will aid in controlling botrytis that might otherwise have developed later. Given good canopy management and well-exposed clusters will dry out better, which acts to prevent botrytis development. In addition, it facilitates spray application of fungicides and will improve spray coverage to the clusters and berries as they ripen.

Virus diseases

[*Information in this section provided by Dr. Naidu Rayapati, Grape Virology, WSU-Prosser.*]
Grapevines are susceptible to a large number of plant viruses. Although virus diseases are not yet a serious problem in maritime western Washington, one must be cautious about the insidious nature of viruses. The movement of plants or plant materials from one place to another always involves the risk of introducing viruses into new areas. Once introduced, it is impossible to eradicate a virus from a vine. The deleterious effects of viruses include reduced vigor and yield, delayed ripening, poor quality of fruit, and decreased longevity of vines. Since viruses cannot be controlled by direct methods (analogous to chemical control of fungal diseases), we use virus-tested cuttings to prevent spread of viruses.

In western Washington, grapevine cultivars are propagated by grafting onto suitable rootstocks to gain security from phylloxera and nematode-borne virus infection, and to promote early ripening in areas of reduced heat units. Many cultivars growing on their own roots often carry latent infections of grapevine viruses and are asymptomatic (that is, they show no signs of infection) until they are grafted onto a rootstock. An exacerbation of disease problems due to rootstock-scion interactions has been reported in many viticultural areas in California and elsewhere. Viruses have been implicated in certain types of graft incompatibility and young vine decline when grafted onto a rootstock in studies conducted elsewhere. Some virus diseases can have severe effects on vines, depending on the cultivar or clonal selections of both the rootstock and scion selections as well as variation among isolates of a virus. Viral infections can significantly reduce the survival rate of grafted vines when compared to grafted virus-tested vines. (See EB0762 *Pest Management Guide for Grapes in Washington* under ***Further Information*** for more details on viruses.)

Bird Control

Keeping birds out of the ripening fruit is of great importance, as starlings, crows, and robins can do an immense amount of damage virtually overnight. Row netting is available in various sizes and lengths, and can be applied and removed fairly effectively using a mechanized system with a tractor or four-wheeler (Fig.13). Fastening the net together with grips or clothespins after it is spread on the vines is more labor intensive but necessary as some birds, particularly robins, can be very persistent in trying to invade the netting. More expensive, wider nets made to drape on the ground minimize the need for fastening and reduce the labor involved. If shoots have spread out into the rows, mechanical pruning or hedging may make it easier to apply netting.

Harvest

As harvest time approaches, begin sampling and testing the fruit. Go down a row and randomly pick 50 to 100 berries from different clusters and different parts of each cluster. Place berry samples in a labeled plastic zip bag, crush the berries in the bag, and snip open one corner to pour out the juice. Have the juice tested for brix, TA, and pH. Test frequently and keep careful record of the results in order to evaluate and compare with the specific target range of values for harvesting each variety. However, it is most important to taste the fruit and try to use your palate to describe flavors. Both factors, juice analysis and tasting, are needed to develop your understanding of when to harvest. Be receptive to information and experience from others, particularly the winemaker, in communicating your harvest objectives.

Fig. 13. *Netting protects the crop from bird damage.*

Glossary

AHU (Accumulated Heat Units)—See **GDD**.

Apical dominance—The tendency of the bud located at the highest point on a cane or shoot to grow the most vigorously.

Brix—Soluble solids or sugar content, measured as percent sugar in juice.

CEC (Cation Exchange Capacity)—The sum total of exchangeable cations that a soil can adsorb, expressed in centimoles per kilogram of soil, used in interpreting soil test results.

GDD (Growing Degree Days)—Sum of the mean monthly temperature above 50°F for the period concerned (in grapes, from April 1 to October 31), expressed as degree-days.

Graft union—The point where rootstock and scion variety are joined.

Macroclimate—Regional climate, typically measured in square miles, depending on geographic factors.

Mesoclimate—Climate of a particular vineyard, which may differ within the regional climate because of factors such as elevation, slope, aspect, etc.

Microclimate—Canopy climate, within and immediately surrounding a plant canopy, which can show differences between small areas within the canopy, i.e., sunlight exposure, humidity, etc.

µE (microEinstein)—Measurement of the number of photons (light units) absorbed by a plant that enables photosynthesis to take place. One µE is equivalent to 6.02×10^{17} photons.

pH—A numerical measure of the acidity or hydrogen ion activity of a substance, e.g., grape juice or soil.

Phylloxera—Grape phylloxera, *Daktulosphaira vitifoliae* (Fitch), is an aphid-like insect that feeds on grape roots, native to the eastern U.S. where American grape species developed a natural tolerance. Susceptible plants decline and die.

PPM—Parts per million, a unit of concentration often used when measuring levels of materials in air, water, etc. One ppm is one part in 1,000,000. The common unit **mg/liter** is equal to one ppm. Four drops of ink in a 55-gallon barrel of water would produce an "ink concentration" of 1 ppm.

Scott Henry system—A method of vine training with two upper and two lower renewal canes in which shoots from the upper canes are trained upward and shoots from the lower canes are trained downward (see *Oregon Winegrape Growers' Guide*, pp. 119–123).

TA—Titratable acid is the measure of acid content in juice.

Teinturier—(pronounced "tain toor yay," French) A grape (e.g., Agria, Golubok, or Dunkelfelder) with deeply colored red juice, often used to give fermenting wine more color.

Terroir—(pronounced "tair wah," French) Term designating the immediate locale (site, soil, conditions) of a specific wine.

Veraison—(pronounced "veh ray zoh," French) Stage of ripeness signalling the start of berry softening and color change.

Vitis—The scientific designation (genus) that includes all grape species.

Vitis vinifera—European grape species, which are the classic standard for wine making.

VSP (Vertical Shoot Positioning)—A method of vine training in which annual canes are tied horizontally to the wires and all new shoots are positioned vertically.

Further Information

WSU Extension Bulletins:

EB1566, *Grape Phylloxera* (Watson, Cone, and Haskett), May 1990, 4pp., $1.00 This bulletin will help you identify phylloxera adults and nymphs on the roots of infested vines. Early detection is important, as quarantine and sanitation are the primary weapons against this pest. http://cru.cahe.wsu.edu/CEPublications/eb1566/eb1566.html

EB0637—*Training & Trellising Grapes for Production in Washington*, (WSU) March 1996, 16pp., $1.50 Drawings and descriptions of conventional and newer trellising systems. Covers spacing, layout, training, and pruning.

EB0742—*Crown Gall of Grapes* (Johnson and Ahmedulla), August 1983, 2pp., $1.00 A photograph and description provide diagnosis and control information.

EB1370—*Botrytis Bunch Rot of Grape* (Johnson and Ahmedulla), April 1986, 2pp., $1.00 Color photographs and discussion about control, sanitation, irrigation, and fungicides are direct and brief.

EB1202—*Powdery Mildew of Grapes in Washington* (Johnson and Ahmedulla), October 1991, 2pp., $1.00 Full color photographs and clear, short discussions explain the symptoms and management of the disease.

EB0762—*Pest Management Guide for Grapes in Washington* (Watson, Olmstead et al.), revised December 2004, 40 pp, $3.50. Guide to control of diseases, insects, weeds, and vertebrate pests on commercial grapes. Weed controls—both soil-active and foliage-applied herbicides—are outlined for new and established plantings. Disease and insect controls are coordinated to pest and crop stage. http://cru.cahe.wsu.edu/CEPublications/eb0762/eb0762.pdf.

MISC0146—*Laboratory Manual for Wineries* (Edwards), July 1990, 80 pp., $6.00. Outlines methods for analysis of musts and wines. With this information, commercial and home winemakers can control levels of alcohol, volatile acidity, and sulfur dioxide. Levels are important to winery quality control and are regulated by Bureau of Alcohol, Tobacco, and Firearms [BATF].

PNW0475—*Soil Water Monitoring & Measurement* (Ley, Stevens et al.), revised September 2000, 36pp. $1.00. Soil characteristics and water holding capacity of different soils. Charts show effective rooting depths for crops. Soil monitoring and tensiometry allow growers to keep track of water in root zones throughout their fields. http://cru.cahe.wsu.edu/CEPublications/ pnw0475/pnw0475.html

Stewardship of Powdery Mildew Fungicides in Perennial Crops (Grove, Nelson, and Xiao) Discussion of effective use of fungicides to prevent development of resistance over time. Available online only: http://fruit.wsu.edu/ Diseases/Fungicide%20Stewardship.pdf

Other Bulletins:

EM8413—*Pest Management Guide for Wine Grapes in Oregon*, April 2005. Available online only: http://eesc.orst.edu/agcomwebfile/edmat/EM8413-E.pdf

EM8882—*Grapevine Rootstocks for Oregon Vineyards* (Shaffer, Sampaio, Pinkerton, and Vasconceles), December 2004, 11pp., $2.00 Includes discussion and tables covering a wide range of grape rootstocks, their performance in areas such as comparative vigor, soil suitability, vegetative cycle. See http://eesc.orst.edu/agcomwebfile/edmat/EM8882.pdf

R.B. 99-01—*Economics of Drip Irrigation for Juice Grape Vineyards in New York State* (Cuykendall, White et al.), March 1999. Outlines the cost considerations and benefits for irrigation systems in a climate where irrigation is often supplemental; includes farm worksheets. http://aem.cornell.edu/research/researchpdf/rb9901.pdf

E-2645—*Vineyard Establishment II: Engineering a Modern Vineyard Trellis* (Zabadal), December 1997. Extensive, detailed instructions for trellis construction, selection and spacing of posts, wire size, and tools for installation. http://grapes.msu.edu/ pdf/cultural/engineerTrellis.pdf

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GRAPE CALENDAR—JANUARY TO JUNE

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
				Mildew spray	Mildew spray
				Early zinc & boron spray: 2 weeks before bloom	Boron spray: at bloom time Zinc & boron spray: post bloom Weed control sprays
Weed control sprays					Mow
Collect cuttings for grafting & propagation					
	Graft and callus plants (until mid-March)				
		Install weather data loggers by April 1	Download weather data	Download weather data	Download weather data
Plant new vines (dormant)			Plant new grafted vines until mid June—***Irrigation is essential***		
Prune					Thin unproductive shoots
					Shoot positioning & training
	Re-tighten trellis wires		Install posts and wires (on second-year plantings)		
		Lay out, trench, and set up irrigation lines			

GRAPE CALENDAR—JULY TO DECEMBER

JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Mildew sprays Botrytis spray before berry clusters close	Mildew sprays Botrytis sprays if needed (wet)	Botrytis sprays	Botrytis sprays		
			Perform soil tests	Apply fertilizer according to soil test	
Mow		Mow			
					Collect cuttings for grafting & propagation
Download weather data	Download weather data	Download weather data	Download weather data	Remove weather data loggers, store	
					Plant new vines
Thin shoots; thin leaves around cluster	Cluster thin at veraison				Prune
Shoot positioning & training	Canopy training & control				
	Put up bird netting			Remove & store nets	
Irrigate as needed					
		Test grapes for ripeness (brix, pH, soluble solids)			
		Harvest early varieties			

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