Wine Grape Cultivar Trials 2000-2008 in the Cool Maritime Climate of Western WA

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Wines produced from grapes grown in cool climate regions have generally low alcohol content, low viscosity, and high fruit aromas and flavor (Casteel, 1992; Jackson and Schuster, 1977; Zoecklein, 1998). Certain varietals from Germany, Austria Russia, Hungary, and Armenia, as well as some common French varieties such as Pinot Noir and Pinot Gris can produce excellent fruity wines in western Washington. Selection of the right clone is important and knowing the heat units of your site will greatly aid in the selection of which varieties to grow. The cool maritime region of western Washington is on the very low end of the spectrum with respect to the number of growing degree days (GDD) needed for ripening the more common wine grape cultivars. Although the Puget Sound region has a long growing season in terms of frost free days, mesoclimates within the area range from below 1200 GDD to 2200 GDD. The Washington State University Mount Vernon Northwestern Washington Research and Extension Center (WSU Mount Vernon NWREC) research site is located at 12 feet above sea level in the Skagit Valley floodplain, 3 miles from the Puget Sound. Since 2002, annual GDD averaged 1693; in 2003 there was a spike in GDD of 1965. Above average GDD were recorded for 2004 and 2005 also, but for 2006 - 2008 the GDD were below average and GDD for the last 2 years were at or slightly below 1500 GDD. This represents one of the coolest mesoclimates in the region (Table 1).

A previous study of wine grape cultivars was conducted at WSU Mount Vernon NWREC from 1975-1985. This study provided essential information on cultivar selection for commercial wine grape producers in western Washington and identified a few, mainly white, wine cultivars (Moulton, 1997 revised). The Washington State University Extension Publication “Growing Grapes for Wine and Table in the Puget Sound Region” EB0775 summarizes the findings from this study.

In 1999 local growers requested that a new cultivar trial be started to identify more red cultivars that produced good wine. Growers needed cultivars that matured at the cooler end of the GDD spectrum, with good profit potential and wine characters (Agria, Zweigelt, Pinot Noir Precoce, Muscat of Norway) This would broaden the range and increase sales potential for the local wineries. A major limiting factor for judging fruit maturity in the region is titratable acid (TA). Under warm growing conditions, fruit is considered mature when the range of TA is 0.7-0.9 for whites and 0.6-0.8 for reds; whereas, in a cool climate, TA readings of 1.0 and below are considered acceptable. The following is a report summarizing the work done from 2000-2008 to test wine grape cultivars in northwest Washington.

In 2000 two wine grape studies were begun at the WSU Mount Vernon NWREC. The first study was a cultivar trial to evaluate 68 wine cultivars. Entries included in this study were recently introduced cultivars, selections, and clones predominantly from cool climate areas (Casteel, 1992; Howell et al., 1999; Jackson and Schuster, 1997; Kerridge and Antcliff, 1999; Kiyomoto, 1994; Reisch et al., 1993; Smart and Robinson, 2000). Also included in this study was previously unavailable material from areas of eastern Europe with similar climate conditions (Avery, 1999; Goodman et al., 1999; Howell et al., 2000). Eight cultivars, Auxerrois, Burmunk, Golubok, Iskorka, Kerner, Muscat of Norway, Pinot Noir Precoce, and St. Laurent (all grafted on Couderc 3309 and/or Millardet et de Grasset 101-14) were

planted in spaces that had come open from early discards; harvest data was compared to previously-established self rooted plants. A smaller trial that included a subset of 38 of these cultivars was also planted at a farm in Concrete, WA so that selected cultivars could be evaluated in a warmer mesoclimate. In 2002 this trial was moved to another location at Everson, Washington with similar GDD levels.

The second study was initiated to evaluate cultivar Pinot Noir 2A grafted on 7 rootstocks and compare the performance of each grafted rootstock to self-rooted plants. Rootstocks were selected not only for pest resistance but also for potential to advance fruit maturity and/or control vine vigor (Catlin, 1991; Candolfi-Vasconceles, 1997; Galet, 1999; May, 1994; Winkler et al., 1974). Two rootstocks that propagate easily, Couderc 3309 and Millardet de Grasset 101-14, were shown to have a significant effect in advancing fruit maturity in this study (Table 2); these results were similar to those of other studies (Shaffer *et al*., 2004).

Based on the results from the rootstock study, 20 promising cultivars were grafted on either Couderc 3309 and/or Millardet et de Grasset 101-14. Nine of those cultivars were used in an observational study (Study 3) to see how these rootstocks impacted maturity on these promising cultivars when compared to a self rooted plant. Cultivars tested were Garanoir, Madeleine Angevine, Optima, Ortega, Pinot Gris (Ruhlander clone), Regent, Schonburger, Siegerrebe and Sylvaner (Table 3). In this same field block an observational Study 4 compared 3 cultivars (Agria, Zweigelt, and Dornfelder) in a spacing trial.

MATERIALS AND METHODS

Study 1 consisted of two parts: a replicated cultivar trial (A) and an observational screening trial (B). The experimental design of Part A included 28 entries in a randomized complete block of 3 replications, with 5 plants per replication. This provided enough fruit to make 5 gallons of wine for most cultivars when the fruit of all 3 replications was combined. All plants were self rooted, cane pruned and trained to wires in a vertical shoot position (VSP) system. Row spacing was 10 feet between rows with 6 feet between plants. The on-farm study in Concrete WA included 38 cultivars and had the same planting plan. This study was moved to Everson in 2002. Part B included 40 cultivars, clones or selections planted in 3-plant plots, which allowed a rapid observational evaluation of the cultivars. As cultivars from this trial showed promise they were multiplied, and added to the main (Part A) trial. Those that did not perform well were removed.

Study 2 consisted of Pinot Noir 2A (Wadenswil clone) grafted on 7 grape rootstocks. Rootstocks were Milllardet et de Grasset 101-14 and 420A, Couderc 3309, Kober 5BB, Malegue 44-53, Riparia Gloire and Teleki 5C. Plants were compared to self rooted plants. Plots each contained 5 plants and were replicated 5 times. Row spacing was 10 feet between rows with 6 feet between plants (Table 2).

Study 3 included 9 cultivars, each grafted on Couderc 3309 and/or Millardet et de Grasset 101-14. The study included 5 plants per plot, planted in rows 8 feet apart with 6 feet between plants. Cultivars were replicated two times on rootstock Courdec 3309 while Optima was replicated 3 times; Madeleine Angevine and Sylvaner were not replicated on Couderc 3309, but were were replicated two times on rootstock Millardet et de Grasset 101-14; all other cultivars except Optima were not replicated (Table 3).

In Study 4 the cultivars Agria, Dornfelder, Zweigelt, and Pinot Noir cl. 777 were grafted on one or both rootstocks Couderc 3309 and Millardet et de Grasset 101-14. Agria and Dornfelder were replicated twice on 3309 and once on 101-14; Zweigelt was replicated twice on 101-14 and once on 3309; and

Pinot 777 was replicated three times on 3309. Each rootstock replicate plot had 24 plants total, with 6 plants at each spacing of 4 feet, 6 feet, 8 feet and 10 feet.

Comparisons were made between grafted plants from Study 3 and 4 and self rooted plants from Study 1. The results and comparisons of these are recorded in Tables 4-12, where grafted plants from Study 3 and 4 are footnoted. Auxerrois, Burmunk, Golubok, Iskorka, Kerner, Muscat of Norway, Pinot Noir Precoce, and St. Laurent planted in the open spaces in Study 1 were compared for maturity with the earlier planted self rooted plants in Study 1.

Data collection in all studies consisted of sampling fruit after veraison and more often (weekly) as cultivars were within 2 weeks of estimated harvest. In the laboratory we measured juice for brix, pH and TA. Berry sampling was done by taking 10 berries from each plant for a sample of 50 berries from each replicated 5-plant plot in 2002-2005; a sample of 30 berries per plot was used in 2006-2008. In Study 1 part B (3 plants/cultivar), a sample of 30 berries total was collected from the 3 plants in each plot At harvest, juice samples were collected for analysis as the grapes were crushed. Because of the varying funding levels during this study period, the scope of data collection was adjusted each year with regard to the number of evaluations that could be performed in that year. In selected years plot yield was weighed and average pounds per plant were calculated. Yield per acre was calculated by multiplying by 907 (plant number per acre using 8 foot x 6 foot spacing).

Brix was measured with a hand-held refractometer and pH with a Beckman pH meter. Level of TA was determined by titrating a 5ml sample of juice in 25 mls of distilled water. A solution of 0.1N NaOH in a burette was slowly metered to the juice sample until the pH of the juice sample reached 8.2. The amount of NaOH solution was recorded and multiplied by .15 to produce the value for TA in mg per 100 mls. Annual GDD were measured using an Avatel RH 52 data logger unit located in the trial plot to record temperatures from April 1 to October 31 each year.

RESULTS AND DISCUSSION

In 2003 the weather provided one of the warmest seasons on record and excellent conditions for evaluating the full range of cultivars in the studies, with 1965 GDD (to October 31, 2003). However, several of the cultivars had not yet come into fruiting. From 2003 to 2008 there was a steady decline each year in GDD, allowing most cultivars to be tested in a wider climatic range (Table 1). In 2007 and 2008, conditions were the most marginal for the cultivars, and those that performed better at the coolest end of the GDD spectrum were identified over the span of these studies. A specific variety with TA levels at 1.0 g/liter or less was considered acceptable for wine making (Tables 4-12). In several cases cultivars grafted on certain rootstocks seemed to show advanced ripening compared with self rooted vines and reached acceptable TA levels at a lower GDD level (Tables 4-12). However, this was not the case with every variety. The difference was most apparent for the varieties that were marginal for ripening in that GDD window.

Another interesting observation also occurred between 2007 and 2008. Although 2008 had higher GDD (1523) than 2007 (1499), ripening was at least 2 weeks earlier in 2007 and bloom was also earlier. For example, for Pinot Noir bloom was July 10, 2007 and July 25, 2008. The spring of 2008 was much cooler than 2007, delaying bloom 2 weeks, but the fall of 2008 was warmer than 2007, allowing cumulative GDD for 2008 to catch up and exceed cumulative GDD for 2007. However, several varieties that ripened in 2007 did not reach acceptable levels of TA in 2008. This suggests that bloom date is a good indicator of when and if a variety will ripen, and early heat will advance that bloom date. In

addition, these 2 years helped identify cultivars that may be acceptable to plant in mesoclimates that drop below 1500 GDD (Table 3).

The following is a discussion of which cultivars have the best chance for success at a specific site, based on GDD. From the information collected in our studies, we have formed **GUIDELINES** to suggest which varietal selections may work best for a specific growing degree range. Wine quality is also a factor and descriptions of the wines are included whenever possible.

Tables 4-12 provide a summary of all the cultivars included in the various studies. Each cultivar is also placed in a specific table that suggests the minimum GDD needed for that cultivar. Some cultivars were tracked for a shorter period due to budget constraints, or they may have been added later or discarded earlier during the study. Discarded cultivars and selections are discussed under "Miscellaneous Cultivars." Yield data may be represented by only one year of data in some cases. **On a site at the cooler end of the GDD spectrum, the cultivars that will work are very limited.** In the warmer areas, more cultivars are available, as they also include the cultivars that ripen in cooler ranges. In addition, our data indicated several of the cultivars matured earlier when grafted on a rootstock (Tables 4-12). In particular it would benefit those growing grapes in the most marginal sites to plant grafted plants. Western Washington has a fairly mild climate that normally stays well above 0-10^{o}F during the winter, so cold damage is rarely an issue. Other regions may need to evaluate cold tolerance of any of these cool season cultivars. In addition, this list is not all-inclusive and should only be used as a **guideline**.

VINEYARD LOCATIONS AT 1600 GDD AND BELOW

White wine cultivars

Among the white wine cultivars tested, a few performed relatively well under the coolest of conditions (below 1500 GDD), and these are summarized in Table 4. Siegerrebe performed well whether self rooted or grafted on a rootstock, and no noticeable differences in TA values were observed. Burmunk, both on rootstock and self rooted, also performed well. However, when GDD approached 1500, grafted plants performed better, registering higher brix and pH, and lower TA. Madeleine Angevine performed well whether self rooted or grafted on a rootstock, even during the coolest years of this study. Ortega performed well in this GDD range, but when grafted on a rootstock had lower TA readings as GDD approached 1500. Auxerrois and Schoenberger, whether self rooted or grafted on rootstock, performed at an acceptable level at GDD closer to 1600 and above. (Table 5).

Red wine cultivars

Among the red cultivars tested, Pinot Noir Precoce performed well on rootstock and self rooted, even when heat levels were at 1500 GDD or slightly lower. However, when grown on either 101-14 or 3309, harvest was earlier (Table 6), suggesting that grafting to one of these rootstocks might allow the variety to be grown below 1500 GDD. Zweigelt, Muscat of Norway, and Agria all performed acceptably when GDD were approximately 1600 or higher. However, as the GDD approached closer to 1500, each of these cultivars performed better when they were grafted on either 101-14 or 3309, whereas the self rooted entries had unacceptable values at this lower GDD range. Garanoir also performed well in this window; however, not enough data were available on the rootstock for comparison (Table 6).

At a vineyard site where GDD often hovers below 1600 and frequently falls below 1500 GDD, best performance in the cooler years has been by: Siegerrebe, Madeleine Angevine, Burmunk, and/or Pinot Noir Precoce; grafted onto either 3309 or 101-14 rootstock (Table 4). If a site usually stays closer to 1600 GDD and higher, also select cultivars from Tables 4, 5 and 6 which include Auxerrois, Ortega or

Schoenberger on rootstock (3309 or 101-14). Red wine cultivars in this range are Pinot Noir Precoce, Zweigelt, Muscat of Norway, Garanoir on rootstock, Agria on rootstock.

Variety Descriptions

WHITE

Siegerrebe does well and ripens below 1500 GDD. The wine it produces has a distinct litchi fruit aroma with some spice and citrus (grapefruit), and several characters resembling Gewürztraminer. This variety loses its acids quite rapidly as it ripens even when self rooted. The study showed that the two rootstocks tested had little impact with regard to lowering TA earlier. Yield numbers suggest that yields of 2 tons per acre are easily attainable; 4-5 tons will require more work, but have been achieved by local growers. Grapes are tender skinned and susceptible to yellow jacket damage followed by rot.

Burmunk is an Armenian grape variety that produces a very early aromatic grape. The aromas display fresh sliced peaches, honey, and some litchi fruit characters, reminiscent of a Riesling. The two rootstocks promoted earlier ripening, with lower TA and higher brix. Therefore, it is advisable to use one of the rootstocks to promote earlier ripening when growing it at around 1500 GDD or lower. Yield is in the range of Siegerrebe at 2-4 tons per acre. Grapes are tender skinned and susceptible to yellow jacket damage followed by rot.

Madeleine Angevine does well below 1600 GDD; limited data comparing self rooted plants to those grown on rootstock indicated little or no significant effect on the lowering of TA levels as temperatures approached 1500 GDD. The wine produced has citrus aromas along with apricot or peach and honey. Yield is in the 3.5 to 7 ton range per acre on self rooted plants; no yield data were available for grafted plants. Grapes are tender skinned and susceptible to yellow jacket damage followed by rot.

Ortega self rooted plants appear to do well at 1600 GDD, similar to Madeleine Angevine. As GDD approach 1500 or lower, our studies suggest that grafting on rootstock enhances the ripening further. The wine produces citrus and litchi fruit aromas. The variety should have a yield potential of approximately 3.5 tons per acre. The fruit is thicker skinned and appears to be somewhat resistant to yellow jacket damage and bunch rot.

Auxerrois has many characters similar to Chardonnay. It performs better at GDD levels closer to 1600 or higher. When temperature drops so that GDD are near 1500 it will be difficult to get proper maturity; brix levels were low and sugar would need to be added when making wine. If the GDD are closer to 1500, particularly with a cool spring, a better option for this variety may be a sparkling wine. The yield is moderate but can reach 3.5 ton per acre.

Schoenberger has very similar wine characteristics to Siegerrebe. The grape clusters are uniform. If attempting to grow this variety below 1600 GDD, it is highly recommended to graft it on a rootstock promoting earlier ripening. If the yearly average GDD is nearer 1500, Siegerrebe would be a better choice. Tonnage has varied but reached above 4 tons per acre in 2003.

RED

Pinot Noir Precoce is a Pinot Noir clone that looks quite promising for the coolest sites. It ripens more than two weeks ahead of any other Pinot Noir clone we have tested. In Germany it is known as ‘Fruheburgunder’ and is grown at the coolest sites. Yield is low, 1.5 to 2 tons an acre. The wine produced is typical Pinot Noir, and the levels of acid and brix are still quite acceptable when harvested below 1500 GDD at Mount Vernon. The two rootstocks also show evidence of advancing ripening on

this variety and we were able to harvest them earlier. The wines exhibit cherry and strawberry aromas particularly in the coolest years. As the GDD increase, raisins form, and can add more raspberry, blackberry, plum and jam aromas to the wine. When the must is cold soaked, brix levels increase, often to above 20 (the sugars are pulled out of the raisins) even in the coolest year. At sites registering GDD below 1500, this variety would be worthy of trial if grafted on a rootstock.

Muscat of Norway self rooted at the Mount Vernon site reached maturity at about 1600 GDD. However, from our studies, as the GDD lingered near 1500 GDD, plants grafted on rootstock recorded lower TA levels compared to the self rooted plants. Also, at these cooler temperatures this variety is slow to accumulate brix above 18. The wine made from Muscat of Norway had a dominant blackberry pie aroma and has great potential as a dessert wine if residual sugar is left after bottling.

Zweigelt has clusters that resemble large Pinot Noir clusters. At around 1600 GDD this variety will reach values for TA below 1g/liter, attain brix close to 20, and make a good wine. When grown in an area where temperatures hover around 1500 GDD, it becomes more difficult to harvest useable grapes. Grafting to one of the trial rootstocks would probably enhance ripeness enough to attain a harvest, but caution should be used if growing this variety much below 1600 GDD. Yield potential is high, but cluster thinning may be needed at cooler sites. In 2003, yield was close to 8 tons per acre; more usual cropping is in the 4 to 6 ton range.

Agria is a *teinturier* (red juice) variety and does well at 1600 GDD; it was noted that raisins formed on the clusters at WSU Mount Vernon when grown at this temperature. At 1500 GDD the self rooted plants did not produce acceptable juice to ferment, but the Agria grown on rootstock was acceptable. However, at this temperature spectrum (1500 GDD), Agria grown on rootstock had low brix, requiring sugar to be added before fermentation, but levels of TA were acceptable, and it made a good wine. This grape offers a choice of winemaking styles. The skin of Agria grapes is quite bitter, and if fermented on the skins the wine will have significantly more bitterness. At WSU Mount Vernon, the crushed grapes were cold soaked for about 5 days, and the pressed juice was dark red with a boysenberry flavor and aroma. The wine was also prepared similar to a white, fermented off the skins, giving it tropical, berry and confectionary aromas. Nice clusters and yields were attained in the 4 to 5 ton range.

Garanoir produces good yield with thick-skinned berries and resistance to botrytis. Although this variety doesn't attain brix much above 18 when grown below 1600 GDD, TA values do drop rapidly as it ripens, making it a variety worthy of trial. Data were not available to give a good wine description with regard to aromas, and it is assumed that at lower GDD sugar will most likely need to be added to the wine. At 1500 GDD it may benefit from being grown on a rootstock, but data were not extensive enough to verify this. Tonnage was attained as high as 8 tons/acre but 3-5 tons may be a more normal range.

VINEYARD LOCATIONS AT 1700 GDD AND BELOW

If you have a site that hovers above 1600 but usually less that 1700 GDD, in addition to the cultivars listed above, Sylvaner, Pinot Gris (early strains), and Iskorka performed well in this GDD range. Iskorka did better when grafted on a rootstock (3309 or 101-14). Optima was marginal at this range unless grafted on a rootstock and even then it would be best to be planted at a site that annually obtains GDD levels closer to 1700 GDD and above (Table 7). For the reds Regent, Dornfelder, Pinot 777 and Pinot 115 on 101-14 performed well at this range (Table 8).

Additional variety descriptions:

WHITE

Sylvaner does not record high brix in this range but generally reaches acceptable levels of acids. It has uniform clusters with a fair to good yield. The wines made from it at Mt Vernon have not been highly aromatic.

Pinot Gris, when grown above 1600 GDD, shows promise to ripen and make a good wine, especially the early strains such as Ruhlander. Wines are very aromatic with floral aromas. Since it is a mutation of Pinot Noir, rootstocks should also enhance the ripeness, although we do not have data to confirm.

Iskorka is a Russian variety whose name means "Sparkle;" it makes a highly aromatic wine with citrus and very flowery aromas. Self rooted plants reach only marginal levels of acid at this GDD range. Grafting on selected rootstocks appears to help lower the TA level, but not enough information is available to confirm this. Its highly aromatic characters indicate that it not only would be a good stand alone variety but might benefit from being blended with Sylvaner to lower acids and enhance aromas.

Optima has characteristics reminiscent of Sauvignon Blanc. At this GDD range self rooted plants are marginal with regard to maturity. However, our limited data indicate that grafted plants have shown reduced TA earlier, and produced a good grape product within this GDD window.

Ortega, Schoenberger, and Auxerrois have been discussed previously; self rooted plants will perform better when grown at this GDD range but grafted plants would still be preferable.

RED

Regent at Mount Vernon when self rooted and grown in the 1700 GDD range, produced grapes with both good brix and acceptable TA levels. This variety would probably benefit from being grafted onto a rootstock; however, no supporting data are available. The wine made from this grape can be on the more viscous side for a western WA red. The grape plant is resistant to powdery mildew and has open clusters that aid in bunch rot control, which indicates good potential for organic production.

Pinot Noir 115 and 777 grown on rootstock and above 1600 GDD have made good wines, with values for brix and TA well within the acceptable range. At this lower heat unit range most of the flavors will be cherry, strawberry and raspberry. Other strains might also work as well. Approaching 1700 GDD, the quality of these strains may change positively as well as some flavor profiles. Tonnage will commonly be in the 2-3 ton range.

Dornfelder loses it acids (below 1g TA) quickly as it approaches ripeness. Quite often, however, brix remains low. Clusters are very large and impressive and yields have been high, reaching 12 ton/acre. In addition, clusters are loose and little or no bunch rot was observed. This variety can ripen successfully below 1600 GDD, but will produce a better product above 1600 GDD. It is uncertain how its earliness would be affected if grafted to a rootstock. Although wines have been made from it in Germany, experiences here, thus far, have not been highly favorable.

Agria and Garanoir, as discussed previously, as self rooted plants would likely reach acceptable acid and brix ratings, but plants grafted on a rootstock would be preferable.

VINEYARD LOCATIONS AT 1800 GDD AND BELOW

The white cultivars observed include Iskorka, Optima, and Muller Thurgau. The red cultivars include Rondo, Pinot 2A on rootstock, and Pinot Noir Pommard on rootstock. Rondo self rooted performed well at this range. Initial data taken in 2008 indicated that grafting on selected rootstocks would lower the required GDD. From our initial data, St Laurent on rootstock looked promising at this GDD window (Table 9).

Additional variety descriptions:

WHITE

Muller Thurgau is an old standard variety in the area, and fruit on self rooted plants grown at very cool sites (under 1600 GDD) remain too acidic and don't ripen fully. It has not been evaluated on a rootstock but may perform better closer to 1700 GDD if grafted. Yield was recorded in the 3 ton range.

Iskorka and Optima both should perform better self rooted at this GDD range, but grafting on a rootstock should enhance maturity (see detailed description above).

RED

Rondo is a *vinifera* cross from Germany grown in England and Denmark, where it has been documented to ripen at GDD ranges lower than 1700. Results at Mount Vernon, however, showed that 1700 to 1800 GDD seems to be the range to reach acceptable TA levels for self rooted plants. The grapes develop high color, and we consider that TA levels will probably be significantly lower when this variety is grafted on a rootstock, which will then allow it to be grown at a cooler GDD level, although this has not been confirmed in trials. Yield was attained in the 3 ton range

St Laurent has similar characteristics to Pinot Noir, however, TA levels can remain quite high. Grafted on an appropriate rootstock and grown at temperatures around 1700 GDD, acceptable values should be reached to ripen grapes and make a good wine. In our plots, observed set was significantly higher when St Laurent was grafted on a rootstock compared with self rooted plants (data not shown). In addition, self rooted plants appear to be quite susceptible to early bunch stem necrosis (EBSN, Jackson and Coombe, 1995). In full production, yields could reach the 3-4 ton range.

Pinot Noir 2A, Pommard, and other clones should ripen to acceptable TA levels at this range, particularly those grafted on an appropriate rootstock.

VINEYARD LOCATIONS AT 1900 GDD AND BELOW

No additional white wine cultivars that are not listed above fall into this category. Red wine cultivars St. Laurent (self rooted), Golubok, and Dunkelfelder performed well in this range (Table 10).

Additional variety descriptions:

RED

Golubok is a Russian variety whose name means "my little pigeon" (a term of endearment). This variety tends to have high acids unless grown at higher GDD. Grafting on an appropriate rootstock should lower TA levels, but this is not confirmed. This is a *teinturier* (red juice) that makes a more viscous tannic wine. Even though brix can be high at cooler GDD levels, the wines have produced bell pepper and vegetable aromas at the lower GDD windows, as well as recording high TA values; this suggests that the grape has not reached proper maturity. Yield was attained in the 3 ton range.

Dunkelfelder is another *teinturier* variety that tends to have higher sugars and also higher acids. It has the opposite characteristics of Dornfelder (Dornfelder has lower acids and lower sugars) and perhaps was used as a blender. The single varietal wines made at Mount Vernon with this variety have not been impressive. Yield was attained in the 4 ton range

St Laurent is previously described above; our data indicate that a higher GDD range seems to be needed for self rooted plants. In addition, from limited observations, early bunch stem necrosis (EBSN) was very prevalent on self rooted plants, whereas little EBSN was observed on grafted plants thus far at Mount Vernon.

VINEYARD LOCATIONS AT 2000 GDD AND BELOW

The information on cultivars in this category was obtained from our warmer Everson plot. In addition to the white wine cultivars previously listed, Red Traminer, Gruner Vetliner grafted on 101-14, and Sauvignon Blanc 01 grafted on 101-14 all reached good levels of maturity. Red wine cultivars Gamaret (self rooted) and Dolcetto grafted on 3309 reached maturity; other successful red varieties were Pinot Noir 2A and Pinot Noir Pommard (Table 11).

Additional variety descriptions:

WHITE

Gruner Vetliner is the number one white varietal in Austria. In our Everson plot the values for brix and TA from grafted plants indicate promise of a premium wine.

Sauvignon Blanc values for brix and TA support this being a promising variety for making a premium wine when grafted on rootstock.

Red Traminer has yields that are rather low; however, brix and TA values indicate promise for making a premium wine.

RED

Dolcetto produces very large clusters; values for brix and TA on grafted plants are favorable to produce a good wine in this GDD range. High yield potential was observed, but specific yield data was not recorded.

Gamaret is a Swiss variety that performed well at this GDD range when self rooted. It may ripen earlier if grafted on a suitable rootstock, but this is not confirmed by trial data. Yield was attained in the 5 ton range.

Pinot clones should perform at this range when self rooted.

VINEYARD LOCATIONS AT 2100 GDD AND BELOW

Chardonnay 76 grafted on 3309 should perform well in this range, going by the 2006 data. At ranges below 2000 GDD, sparkling wines may be a viable option (Table 12). Kerner on rootstock should make a very good Riesling type wine. No new reds were identified in this range.

Additional variety descriptions:

WHITE

Chardonnay 76 should obtain acceptable TA levels for making a good wine in this GDD range when grafted on rootstock.

Kerner was developed in Germany as an early Reisling; self rooted plants should ripen sufficiently at this range and may attain ripeness at an earlier GDD level if on rootstock, but this is not confirmed. Kernling is a mutation of Kerner grown in the UK, though not tested here, which reportedly ripens at least 2 weeks earlier and thus should ripen at lower GDD.

A final note for consideration is that the number of GDD in a season is not the only factor that affects ripening. With regard to temperature influence, the time of year when heat levels are high has a significant impact on ripening time and harvest characteristics. For example, at Mount Vernon in 2007 the GDD were 1499 and in 2008 GDD were 1523. Both years were quite challenging with respect to successful ripening. However, in 2007 fruit ripened comparatively earlier, despite registering lower heat levels overall. Spring temperatures in 2008 were much cooler than the equivalent period in 2007, and bloom was 2 weeks later in 2008 compared with 2007. Although some additional heat late in the fall of 2008 pushed the final GDD level above that recorded in 2007, the fruit was further behind in maturity in 2008. Recorded values for harvest juice analysis of brix and TA showed this clearly. This issue can become critical for a very marginal site. In addition, consider other factors affecting maturity. For example, soil fertility should be sufficient and balanced. Best cultural practices should be adopted with respect to canopy and crop load management, pest control, and water management. Finally, in very cool years it may be beneficial to have an option of making a sparkling wine when the acids remain too high.

MISCELLANEOUS CULTIVARS FOR THE MARITIME CLIMATE OF WESTERN WASHINGTON

Some cultivars and selections were eliminated early in the study when they showed lack of promise **(**Table 13**)**. A more comprehensive study might reveal characteristics worth further evaluation in some of these discarded cultivars. Such cultivars as Perle of Csaba, Reichensteiner, Nero and Saperavi ripened at the lower GDD ranges, but data on wine quality was too limited, and where the initial wine quality was below an acceptable standard, the variety was discarded. Cultivars that showed no promise above 1800 GDD at the Mt Vernon site in the early part of the study were eliminated. Some of them were added to the warmer Everson plot but this warmer off-station plot had space limitations so not all cultivars could be added to the field study.

At the Everson study site, Goesji Zumalos had good values for brix and pH in the 1900 GDD range but the trial concluded before it could be fully evaluated. The cultivars Phoenix, Pitos, Plai, Rieslander, Riesling Muscat, Siewiernyl, and Tinta Mudera were entered in the last two years of the trial, and evaluations on them were not completed. Other cultivars, Baco Noir, Gamay Freaux, Gamay Rouge, Lagrein, and Aligote as self rooted plants had adequate numbers above 2000 GDD, but even at the warmer Everson site they did not consistently reach these levels during the study. The scope of the study did not permit increasing plant numbers and replications of these cultivars at this site.

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Table 1. Two western Washington mesoclimates: comparision of GDD at Mount Vernon (MV) in Skagit County and Everson in Whatcom County, 2003-2008 (recorded by on-site Avatel data loggers).

Location	2002	2003	2004	2005	2006	2007	2008
MV (F) Celsius	1527* 830	1965 1073	1817 992	1727 942	1600 871	1499 815	1523 828
Everson (F) Celsius	---	2147 1175	2075 1135	1897 1036	1948 1064	1684 918	1587 863

*To October 8th Mt Vernon only; no data was taken in Everson in 2002

Table 2. Comparisons of titratable acids (TA) in mg/100ml of juice of Pinot Noir 2A when grown on rootstocks and self rooted from 2002 to 2007 at WSU Mount Vernon NWREC.

Rootstock	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Self rooted	1.53 a	1.32 a	1.26 a	1.42 a	1.67 a	1.51 a
5BB	1.23 b	1.25 a				
44-53	1.22 b	1.10 ab				
5C	1.22 b	1.25 a				
Riparia Gloire	1.21 b	1.20 ab				
3309	1.08 bc	1.01 b	0.90 b	1.18 b	1.20 b	1.28 b
420A	1.07 bc	1.01 b	0.92 b	0.94 c	1.29 b	1.22 b
101-14	1.00 c	0 .99 b	0.94 b	1.10 bc	1.16 b	1.22 b

Table 3. Advanced cultivar trial (Study 3) on rootstocks Couderc 3309 and Millardet et de Grasset 101-14 at WSU Mount Vernon NWREC planted in 2005 at WSU Mount Vernon NWREC.

Cultivar	**3309**	**101-14**	**Cultivar**	**3309**	**101-14**
Garanoir	2[1]	1[1]	Regent	2[1]	1[1]
Madeleine Angevine	1	2	Schonburger	2	1
Optima	3	0	Siegerrebe	2	1
Ortega	2	1	Sylvaner	1	2
Pinot Gris, Ruhlander	2	1			

[1]number of replications

Table 4. White wine cultivars that performed well with respect to titratable acids (TA) in mg/100ml at 1500 or lower at WSU Mount Vernon NWREC.

Cultivar/Rootstock	**T. A. 2007**[1]	**T.A. 2008**[2]
Siegerrebe (W) / rootstock[3]	0.47	0.62
Siegerrebe (W) / self	0.48	0.65
Madeleine Angevine (W) / rootstock	0.83	0.94 / 0.92[4]
Madeleine Angevine (W) / self	0.81	0.99
Pinot Noir Precoce (R) / rootstock	0.66	0.99
Pinot Noir Precoce (R) / self	0.69	---[5]
Burmunk (W) / rootstock	0.77	0.89

[1] 1499 GDD recorded in 2007
[2] 1523 GDD recorded in 2008.
[3] Grafted plant from Study 3 used to compare with self rooted plants in Study 1.

[4] First reading is rootstock C3309, second reading is rootstock 101-14.
[5] Data not recorded.

Table 5. White wine cultivars maturing at 1600 GDD or lower at WSU Mount Vernon NWREC.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Auxerrois SR[1]							
Harvest Date		Oct. 4		Oct. 23	Oct.23	Oct 28	
Yield per Plant (lbs/plant)		3.15		-	8.4	-	
Brix		18.1		19	18	13.6	
Titratable Acid		0.69		0.69	0.8	1.29	
pH		2.94		2.96	3.03	2.85	
Auxerrois				101-14	combined rootstocks	C3309/ 101-14[4]	
Harvest Date				Sept 28	Oct.23	Oct 28	
Yield per Plant (lbs/plant)					9.2	-	
Brix				15.4	17.6	13.4 / 12.7	
Titratable Acid				1.02	0.83	1.47 / 1.27	
pH				2.85	3.02	2.86 / 2.93	
Burmunk SR							
Harvest Date	Oct 3	Sept 10	Sepe 22	Septe 27	October 2	October 22	2008-juices frozen
Yield per Plant (lbs/plant)	5.1	4.83	2.3	-		-	harvested 10/17/08
Brix	23.2	20.7	19.3	17	15.2	16.55	
Titratable Acid	0.98	0.83	0.73	0.83	1.02	1.07	
pH	3.15	3.21	3.19	2.98	3.0	2.885	
Burmunk				101-14	combined rootstocks	C3309/101-14	
Harvest Date				Sept 28	Sept 25	Oct 22	
Yield per Plant (lbs/plant)				-	6.9	-	
Brix				20.7	19.6	17.2 / 19.7	
Titratable Acid				0.77	0.77	0.86 /0.91	
pH				3.04	3.03	2.96 /2.99	
Madeline Angevine SR							
Harvest Date	Sept 15	Septe 21	Sept 30	Sept 28	Sept 25	Oct 22	
Yield per Plant (lbs/plant)		8.34	15.83		12.4	-	
Brix	15	19.4	20	17.6	18	17.1	
Titratable Acid	1.02	0.7	0.84	0.75	0.81	0.99	
pH	3.41	3.73	3.2	3.18	3.03	3.01	
Madeline Angevine[2]					combined rootstocks	C3309/101-14	
Harvest Date					Sept 25	Oct 22	
Yield per Plant (lbs/plant)					14.9	-	
Brix					17.2	17.2 / 18	
Titratable Acid					0.83	0.94 / .92	
pH					3.08	3.04 / 2.94	
Ortega SR							

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Harvest Date		Sept 21	Sept 22	Sept 28	Oct 23	Oct 28	
Yield per Plant (lbs/plant)		5.54	7.33	-	3.2	-	
Brix		20.1	21	17.9	21.2	17.2	
Titratable Acid		0.7	0.89	0.99	0.87	1.01	
pH		3.76	3.2	3.05	3.02	3.06	
Ortega[2]					combined rootstocks	C3309/101-14	
Harvest Date					Oct 23	Oct 28	2008- some plants water
Yield per Plant (lbs/plant)					3.9	-	stressed
Brix					20.6	18.2 /18	
Titratable Acid					0.81	1.13 / 1.08	
pH					3.15	3.04 / 3.04	
Schoenberger SR							
Harvest Date	Oct 3	Oct 4	Sept 22	Sept 23	Sept 9	Oct 30	
Yield per Plant (lbs/plant)	10.25	1.82	3.01	-	-	-	
Brix	20.4	16.2	17.9	17.9	17.8	15.23	
Titratable Acid	0.74	0.75	1.13	0.77	0.82	1.26	
pH	3.77	2.97	3.06	2.9	3.04	3.18	
Schoenberger[2]					combined rootstocks	C3309/101-14	
Harvest Date					Oct 9	Oct 30	
Yield per Plant (lbs/plant)					-	-	
Brix					17.8	15 / 14.6	
Titratable Acid					0.6	1.19 / 1.23	
pH					3.13	3.27 / 3.22	
Siegerrebe SR							
Harvest Date	Sept 15		Sept 22	Sept 28	Sept 25	Oct 8	
Yield per Plant (lbs/plant)	-		5.32	-	4.2	-	
Brix	17.4		22.6	18	17.8	15.9	
Titratable Acid	0.45		0.54	0.45	0.48	0.65	
pH	3.73		3.62	3.46	3.54	3.18	
Siegerrebe [2]					C 3309	C3309/101-14	
Harvest Date					Sept 25	Oct 8	-
Yield per Plant (lbs/plant)					2.7	-	
Brix					18.8	16.2 /16.0	
Titratable Acid					0.47	0.59 / .65	
pH					3.48	3.33 / 3.36	

[1] SR=self rooted

[2] Readings from plants grafted on C3309 and 101-14 listed separately in order: C3309 / 101-14.

[3] Grafted plant from study 3 used to compare with self rooted plants in study 1

Table 6. Red wine cultivars that matured at 1600 GDD or lower at WSU Mount Vernon NWREC.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Agria[2] (SR[1])							
Harvest Date	Oct 5	Oct 4	Sept 29	Oct 11	Oct 25	Oct 28	
Yield per Plant (lbs/plant)	8.89	4.65	4.23	-	7.60	-	
Brix	20.4	19.2	20.0	18.5	19.0	15.8	
Titratable Acid	0.74	0.62	0.95	0.56	1.19	1.49	
pH	3.93	3.33	3.39	3.12	3.20	3.00	
Agria[3]					Combined Rootstock	C3309/101-14[4]	
Harvest Date					Oct 23	Oct 29	
Yield per Plant (lbs/plant)					10.3	-	
Brix					18.4	14.7 / 15.6	
Titratable Acid					0.66	1.03 / 1.17	
pH					3.63	3.70 / 3.69	
Garanoir (SR)							
Harvest Date	Oct 6	Oct 4	Oct 11	Oct 11		Nov 12	
Yield per Plant (lbs/plant)	18.51	7.10	5.71	-		-	
Brix	17.7	17.9	19.1	18.2		15.4	
Titratable Acid	0.96	0.75	0.63	0.53		1.11	
pH	3.70	3.04	3.65	3.09		3.43	
Garanoir[2]						C3309/ 101-14	
Harvest Date						Nov 12	
Yield per Plant (lbs/plant)						-	
Brix						16.2 / 14.6	
Titratable Acid						1.01 / 1.20	
pH						3.49 / 3.01	
Muscat of Norway (SR)							
Harvest Date	Sept 15	Oct 4	Sept 30	Oct 11	Oct 25	Oct 29	
Yield per Plant (lbs/plant)	-	1.99	-	-	17.80	-	2008- tested after cold soak
Brix	17.8	19.3	17.6	19.0	17.2	18.6	
Titratable Acid	0.89	0.74	0.71	0.72	1.02	1.29	
pH	3.32	3.06	3.24	3.14	3.11	3.37	
Muscat of Norway				101-14	Combined Rootstock	C3309/101-14	
Harvest Date				Sept 28	Oct 25	Oct 29	2008- tested after cold soak
Yield per Plant (lbs/plant)					4.3	-	
Brix				18.1	19.0	19.4 /19.8	
Titratable Acid				0.86	0.84	1.25 / 1.30	
pH				2.94	3.06	3.35 / 3.38	
Pinot Noir Precoce (SR)							
Harvest Date			Sept 29	Sept 28	Oct 23		
Yield per Plant			-	-	4.3		

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
(lbs/plant)							
Brix			21.3	18.9	20.8		
Titratable Acid			0.81	0.68	0.69		
pH			3.31	2.93	3.53		
Pinot Noir Precoce				C3309/101-14	C3309/101-14	Self & Rootstock combined	
Harvest Date				Sept 27	Oct 5	Oct 22	2007- After cold soak
Yield per Plant (lbs/plant)				-	3.6 / 2.8		
Brix				18.6 /19.2	20.6 / 20.6	20.0	
Titratable Acid				1.00 /0.93	0.6 0/ 0.66	0.99	
pH				3.13 /3.11	3.39 /3.39	3.18	
Zweigelt (SR)							
Harvest Date	Oct 18	Oct 4	Oct 11	Oct 23	Oct 11	Oct 30	
Yield per Plant (lbs/plant)	17.59	9.74	4.07	10.87		-	
Brix	18.4	19.5	21.1	18.7	18.0	14.9	
Titratable Acid	0.98	0.95	0.81	0.85	1.12	1.68	
pH	3.79	2.88	3.58	2.65	2.87	3.03	
Zwiegelt[3]					C3309	C3309/101-14	
Harvest Date					Oct 26	Oct 30	
Yield per Plant (lbs/plant)					24.1	-	
Brix					18.2	15.2 / 14.9	
Titratable Acid					0.83	1.40/ 1.29	
pH					3.02	3.10 / 3.15	

[1] SR=self rooted
[2] Grafted plant from study 3 used to compare with self rooted plants in study 1
[3] Grafted plant from study 4 used to compare with self rooted plants in study 1
[4] Readings from plants grafted on C3309 and 101-14 listed separately in order: C3309 / 101-14.

Table 7. White wine cultivars that matured at 1700 GDD or lower at WSU Mount Vernon NWREC.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Auxerrois (SR[1])							
Harvest Date		Oct 4		Oct. 23	Oct 23	Oct 28	
Yield per Plant (lbs/plant)		3.15		-	8.40	-	
Brix		18.1		19.0	18.0	13.6	
Titratable Acid		0.69		0.69	0.80	1.29	
pH		2.94		2.96	3.03	2.85	
Iskorka (SR)							
Harvest Date	Oct 3	Sept 24	Sept 22	Sept 28	Oct 23	Nov 12	
Yield per Plant (lbs/plant)	4.98	4.90	2.37	-	2.00	-	
Brix	20.2	21.5	20.8	17.8	20.8	20.4	
Titratable Acid	0.71	0.60	0.86	1.17	1.08	1.31	
pH	3.68	3.09	3.05	2.79	2.98	3.33	

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Iskorka				101-14	Combined Rootstock	C3309/101-14[3]	
Harvest Date				Sept 28	Oct 23	Nov 12	
Yield per Plant (lbs/plant)				-	5.1	-	
Brix				17.0	20.6	19.8 / 21.0	
Titratable Acid				0.99	0.99	1.49 / 1.32	
pH				2.80	2.98	3.27 / 3.33	
Optima (SR)							
Harvest Date		Sept 24	Sept 30	Sept 28	Oct 23	Oct 30	
Yield per Plant (lbs/plant)		6.06	8.59	-	7.20	-	
Brix		17.8	18.3	15.4	19.6	17.4	
Titratable Acid		0.77	1.05	1.13	1.02	1.31	
pH		3.14	2.99	2.92	3.04	3.20	
Optima[2]					Combined Rootstock	C3309	
Harvest Date					Oct 23	Oct 30	
Yield per Plant (lbs/plant)					7.9	-	
Brix					20.2	15.8	
Titratable Acid					0.95	1.43	
pH					2.99	3.32	
Ortega (SR)							
Harvest Date		Sept 21	Sept 22	Sept 28	Oct 23	Oct 28	
Yield per Plant (lbs/plant)		5.54	7.33	-	3.20	-	
Brix		20.1	21.0	17.9	21.2	17.2	
Titratable Acid		0.70	0.89	0.99	0.87	1.01	
pH		3.76	3.20	3.05	3.02	3.06	
Pinot Gris [Ruhlander] (SR)							
Harvest D*ate*		Oct 4	Oct 11	Oct 23	Oct 23	Oct 30	
Yield per Plant (lbs/plant)		2.43	4.82	10.10	4.10	-	
Brix		18.8	20.2	18.8	20.2	19.0	
Titratable Acid		0.86	0.98	0.87	1.40	1.43	
pH		2.86	3.53	2.81	2.91	3.45	
Schoenberger (SR)							
Harvest Date	Oct 3	Oct 4	Sept 22	Oct 23	Oct 9	Oct 30	
Yield per Plant (lbs/plant)	10.25	1.82	3.01	-	-	-	
Brix	20.4	16.2	17.9	17.9	17.8	15.2	
Titratable Acid	0.74	0.75	1.13	0.77	0.82	1.26	
pH	3.77	2.97	3.06	2.90	3.04	3.18	
Sylvaner (SR)							
Harvest Date	Oct 13	Oct 4	Oct 11	Oct 23	Oct 23		
Yield per Plant (lbs/plant)	8.01	11.67	5.76	-	15.70		
Brix	16.8	15.5	16.9	15.8	16.6		
Titratable Acid	0.90	0.80	0.94	0.78	1.07		
pH	3.70	3.00	3.62	2.83	2.92		

[1] SR=self rooted

[2] Grafted plant from study 3 used to compare with self rooted plants in study 1
[3] Readings from plants grafted on C3309 and 101-14 listed separately in order: C3309 / 101-14.

Table 8. Red wine cultivars that matured at 1700 GDD or lower at WSU Mount Vernon NWREC.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Agria (SR)							
Harvest Date	Oct 5	Oct 4	Sept 29	Oct 11	Oct 25	Oct 28	
Yield per Plant (lbs/plant)	8.89	4.65	4.23	-	7.60	-	
Brix	20.4	19.2	20.0	18.5	19.0	15.8	
Titratable Acid	0.74	0.62	0.95	0.56	1.19	1.49	
pH	3.93	3.33	3.39	3.12	3.20	3.00	
Agria [2]					Combined Rootstock	C3309/101-14[3]	
Harvest Date					Oct 23	Oct 29	
Yield per Plant (lbs/plant)					10.3	-	
Brix					18.4	14.7 / 15.6[3]	
Titratable Acid					0.66	1.03 / 1.17	
pH					3.63	3.70 / 3.69	
Dornfelder (SR)							
Harvest Date	Oct 18	Oct 4	Oct 11	Oct 23			
Yield per Plant (lbs/plant)	14.11	14.44	6.54	-			
Brix	17.6	16.0	18.0	16.6			
Titratable Acid	0.89	0.77	0.90	0.74			
pH	3.76	-	3.58	2.79			
Garanoir (SR)							
Harvest Date	Oct 6	Oct 4	Oct 11	Oct 11		Nov 11	
Yield per Plant (lbs/plant)	18.51	7.10	5.71	-		-	
Brix	17.7	17.9	19.1	18.2		15.4	
Titratable Acid	0.96	0.75	0.63	0.53		1.11	
pH	3.70	3.04	3.65	3.09		3.43	
Pinot 777[2]		44-53	44-53	101-14	C3309	C3309	
Harvest Date		Oct 27	Oct 11	Sept 27	Oct 25	Oct 28	
Yield per Plant (lbs/plant)		2.9	-	-	6.4	-	
Brix		18.6	19.8	18.3	19.8	17.1	
Titratable Acid		1.14	0.93	0.93	1.13	1.32	
pH		2.97	3.68	2.93	3.10	2.96	
Pinot 115				101-14			
Harvest Date				Sept 27			
Yield per Plant (lbs/plant)				-			
Brix				15.9			
Titratable Acid				1.08			
pH				2.87			
Pinot 115				Riparia			
Harvest Date				Oct 23			
Yield per Plant (lbs/plant)				-			

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Brix				18.0			
Titratable Acid				1.25			
pH				2.71			
Regent (SR)							
Harvest Date	Oct 13	Oct 4	Oct 11	Oct 23		Oct 30	
Yield per Plant (lbs/plant)	6.58	2.40	1.73	-		-	
Brix	19.6	21.2	22.6	21.2		19.0	
Titratable Acid	0.89	0.72	1.07	0.81		1.39	
pH	3.76	3.05	3.69	3.08		3.23	

[1] SR=self rooted
[2] Grafted plant from study 4 used to compare with self rooted plants in study 1
[3] Readings from plants grafted on C3309 and 101-14 listed separately in order: C3309 / 101-14.

Table 9. White and red wine cultivars that matured at 1800 GDD or lower at WSU Mount Vernon NWREC.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
WHITE							
Iskorka (SR[1])							
Harvest Date	Oct 3	Sept 24	Sept 22	Sept 28	Oct 23	Nov 12	
Yield per Plant (lbs/plant)	4.98	4.90	2.37	-	2.00	-	
Brix	20.2	21.5	20.8	17.8	20.8	20.4	
Titratable Acid)	0.71	0.60	0.86	1.17	1.08	1.31	
pH	3.68	3.09	3.05	2.79	2.98	3.33	
Muller Thurgau (SR)							
Harvest Date		Oct 4	Oct 11				
Yield per Plant (lbs/plant)		5.48	6.28				
Brix		18.1	19.2				
Titratable Acid		0.71	0.90				
pH		2.87	3.60				
Optima (SR)							
Harvest Date		Sept 24	Sept 30	Sept 28	Sept 23	Sept 30	
Yield per Plant (lbs/plant)		6.06	8.59	-	7.20	-	
Brix		17.8	18.3	15.4	19.6	17.4	
Titratable Acid		0.77	1.05	1.13	1.02	1.31	
pH		3.14	2.99	2.92	3.04	3.20	
RED							
Pinot 2A (SR)							
Harvest Date	Oct 27	Oct 14	Oct 11	Oct 23	Oct 25		
Yield per Plant (lbs/plant)	11.0	-	-	9.9	4.9		
Brix	19.8	18.0	18.6	18.3	18.1		
Titratable Acid	1.32	1.26	1.42	1.67	1.51		
pH	3.10	3.00	3.45	2.63	2.94		

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Pinot 2A	C3309/101-14[2]	C3309/101-14	C3309/101-14	C3309/101-14	C3309/101-14		
Harvest Date	Oct 27	Oct 14	Oct 11	Oct 23	Oct 25		
Yield per Plant (lbs/plant)	7.20 /10.20		-	5.28 / 6.26	6.20 /5.40		
Brix	21.0 / 20.5	19.7 / 19.7	18.9 / 18.7	18.8 / 19.1	18.8 /18.9		
Titratable Acid	1.01 /0 .99	0.90 / 0.94	1.18 / 1.10	1.20 / 1.16	1.28 /1.22		
pH	3.28 / 3.20	3.11 / 3.10	3.53 / 3.55	2.75 / 2.74	3.02 /3.03		
Pinot Noir Pommard				C3309			
Harvest Date				Sept 27			
Yield per Plant (lbs/plant)				-			
Brix				16.4			
Titratable Acid				1.11			
pH				2.89			
Pinot Noir Pommard			Riparia	Riparia			
Harvest Date			Oct 11	Sept 27			
Yield per Plant (lbs/plant)			-	-			
Brix			18.1	15.7			
Titratable Acid			1.17	1.10			
pH			3.61	2.88			
Rondo (SR)							
Harvest Date			Oct 5	Sept 28	Oct 25	Oct 29	
Yield per Plant (lbs/plant) (lbs/plant)			-	-	5.1	-	
Brix			20.8	18.6	19.4	20.0	
Titratable Acid			1.02	1.10	1.17	1.32	
pH			3.29	2.84	3.12	3.40	
Rondo						101-14	
Harvest Date						Oct 30	
Yield per Plant (lbs/plant)						-	
Brix						19.0	
Titratable Acid						1.16	
pH						3.45	
St. Laurent (SR)							
Harvest Date	Oct 27	Oct 11		Sept 28			
Yield per Plant (lbs/plant)	13.00	5.72		-			
Brix	17.6	17.3		15.6			
Titratable Acid	1.19	0.86		1.64			
pH	3.82	3.15		2.76			
St Laurent				101-14	Combined Rootstock		
Harvest Date				Sept 28	Oct 25		
Yield per Plant (lbs/plant)				-	6.4		
Brix				16.7	18.2		
Titratable Acid)				1.20	1.14		
pH				2.78	3.07		

[1] SR=self rooted
[2] Readings from plants grafted on C3309 and 101-14 listed separately in order: C3309 / 101-14.

Table 10. Red wine cultivars that matured at 1900 GDD or lower at WSU Mount Vernon NWREC.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**1965**	**1817**	**1727**	**1600**	**1499**	**1523**	
Dunkelfelder (SR[1])							
Harvest Date	Oct 18	Oct 4	Sept 15	Sept 28			
Yield per Plant (lbs/plant)	9.75	4.07	-				
Brix	20.2	17.5	16	15.1			
Titratable Acid	1.1	0.98	1.26	1.2			
pH	3.85	3.11	2.75	2.98			
Golubok (SR)							
Harvest Date	Oct 18	Oct 14	Oct 11	Oct 23			
Yield per Plant (lbs/plant)	5.6		4.41	-			
Brix	21.7	21.8	21	19.4			
Titratable Acid	1.25	1.05	1.31	1.22			
pH	4.15	3.15	3.65	2.68			
Golubuk				101-14			
Harvest Date				Sept 28			
Yield per Plant (lbs/plant)							
Brix				17.3			
Titratable Acid				1.19			
pH				2.83			
St. Laurent (SR)							
Harvest Date	Oct 27	Oct 11		Sept 28			
Yield per Plant (lbs/plant)	13	5.72					
Brix	17.6	17.3		15.6			
Titratable Acid	1.19	0.86		1.64			
pH	3.82	3.15		2.76			

[1] SR=self rooted

Table 11. Red [red] and white wine cultivars that matured at 2000 GDD or lower at Everson, WA.

Year	2003	2004	2005	2006	2007	2008	Notes
GDD	**2147**	**2075**	**1867**	**1948**	**1684**	**1587**	
Dolcetto [red]				C3309			
Harvest Date				Sept 26			
Yield per Plant (lbs/plant)							
Brix				18.6			
Titratable Acid				0.95			
pH				3.24			
Gamaret [red[(SR[1])							
Harvest Date	Oct 27	Oct 5	Oct 11				
Yield per Plant (lbs/plant)		-	13.02				
Brix	18.6	18.1	19				
Titratable Acid	0.95	0.42	1.07				

pH	3.18	2.95	3.04				
Gruner Vetliner				101-14			
Harvest Date				Oct 11			
Yield per Plant (lbs/plant)							
Brix				22.2			
Titratable Acid				0.98			
pH				3.02			
Red Traminer (SR)							
Harvest Date		Oct 5	Oct 11				
Yield per Plant (lbs/plant)		0.58	0.73				
Brix		21.8	22.6				
Titratable Acid		0.56	0.92				
pH		3.07	3.3				
Sauvignon Blanc 01				101-14			
Harvest Date				Sept 26			
Yield per Plant (lbs/plant)				-			
Brix				20.8			
Titratable Acid				0.89			
pH				3.04			

[1] SR=self rooted

Table 12. White wine cultivars that matured at 2100 GDD or lower at Everson WA.

Year	2003	2004	2005	2006	2007	2008	Notes
Everson GDD	**2147**	**2075**	**1867**	**1948**	**1684**	**1587**	
Chardonnay 76				C3309			
Harvest Date				Sept 26			
Yield per Plant (lbs/plant)				-			
Brix				19.3			
Titratable Acid				1.1			
pH				3.03			
Chardonnay 76				101-14			
Harvest Date				Sept 11			
Yield per Plant (lbs/plant)				-			
Brix				17.2			
Titratable Acid				1.13			
pH				3.00			
Kerner (SR)							
Harvest Date		Oct 5	Oct 11				
Yield per Plant (lbs/plant)		1.6	2.57				
Brix		21.6	20				
Titratable Acid)		0.75	1.31				
pH		2.65	2.83				

[1] SR=self rooted

Table 13. Cultivars and selections discarded from trial at WSU Mount Vernon NWREC and at Everson, 2003-2008.

Cv	Pltd	Disc	Notes
Alicante	2000	2005	In pretest; late and not impressive self rooted
Bianca[1]	2001	2007	needs heat level above 1800 GDD to ripen well
Bromariu[1]	2001	2003	too late
CSFT 194[1]	2001	2003	too late
CSFT 195[1]	2001	2003	too late
Demetra	2001	2003	too late
Gamay Chaudenay	2000	2007	needs heat level above 2000 GDD to ripen well; not impressive at either site
Gamay Freaux	2000	2003	ripened above 2000 GDD at Everson, too late at MV, not impressive at either site
Gamay Noir	2000	2003	too late
Gamay Rouge de la Loire	2000	2003	ripened above 2000 GDD at Everson, too late at MV
I 31/67[1]	2001	2004	poor quality, ripened about 1800 GDD
II 70/21[1]	2001	2003	too late
Johnson clone	2001	2003	too late
Juwel	2000	2003	too late, severe susceptibility to powdery mildew
K 15[1]	2001	2003	too late, poor quality
K 38[1]	2001	2003	too late
Kozma Pal Muskataly	2001	2003	too late
Kozma 55[1]	2000	2003	too late, needs minimum 2000 GDD
Kozma 525[1]	2000	2003	too late
L 4-9-18[1]	2001	2003	too late
Lagrein	2001	2007	too late for Everson self rooted
Laurot (MI 5-106)[1]	2000	2003	3 plants retained in pretest
Liza (SK77-12/6)[1]	2001	2007	needs heat level above 1800 GDD to ripen well
Malverina (BV19-143)[1]	2001	2003	too late
M 39-4/63[1]	2001	2003	too late
M 39-9/7488[1]	2000	2003	too late
Malbec	2000	2007	pretest Everson only, discard at MV, too late
Nero	2001	2005	mediocre wine quality, ripens about 1800 GDD
Perle of Csaba	2000	2007	ripens below 1600 GDD, very early, lacks aroma, best as a possible blender
Petra (SK 77-5/3)[1]	2001	2007	needs heat level above 1800 GDD to ripen well
Pinot Blanc	2000	2003	pretest only, too late in MV
Rani Riesling[1]	2001	2007	needs heat level above 1800 GDD to ripen well
Regner	2000	2008	needs heat level around 1800 GDD or better
Reichensteiner	2004	2007	Ripens very early, thin, only fair quality
Reislander	2004	2008	Too late at MV, not fully evaluated at Everson
Rubin Tairovski.	2000	2003, 2007	needs heat level above 1800 GDD to ripen well
Saperavi	2005	2008	good at 1600 GDD but clusters didn't fill, yield very light

Toldi	2001	2008	brix too low, ripens aboutt 1800 GDD
Viorica	2001	2007	needs heat level above 1800 GDD to ripen well
XIV 11-57	2000	2003	too late
XIV 1-86	2001	2003	too late
XX 15-51	2001	2003	too late

[1]tested only at WSU Mount Vernon NWREC