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Vineyard Establishment for the Connecticut Homeowner

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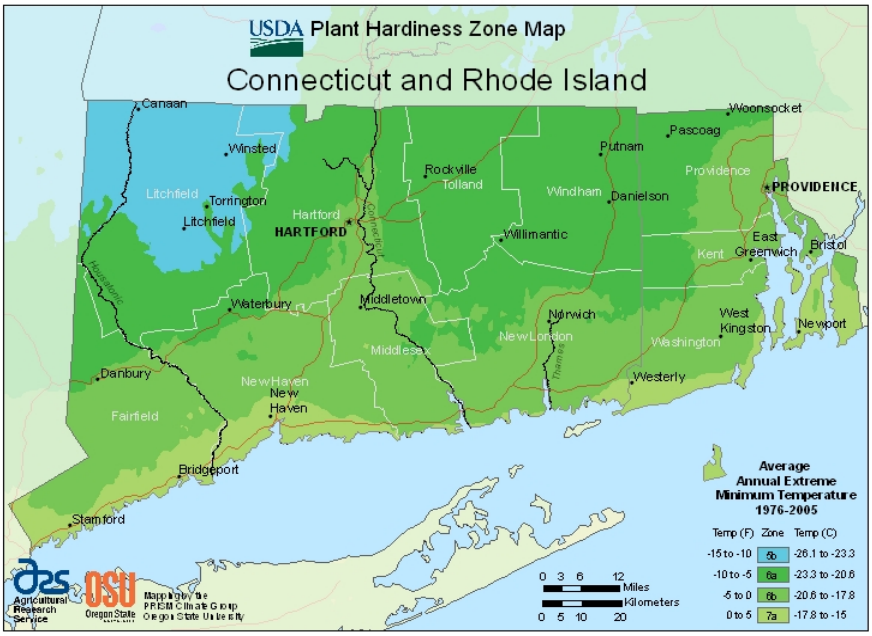
Abstract

Proper planning is critical for establishing a healthy, successful vineyard. The steps include: Site selection, cultivar selection and planting, trellising and training, growth and maintenance, disease and insect scouting, and harvest.

Site Selection

Successfully growing grapes begins with proper site selection and preparation. Determine if your property has the requirements for grapes because it typically takes three years before a harvestable crop can be obtained. Changing to a new location is time consuming and costly once vines are planted and trellising is installed. Zones 6a and b are a safe bet in the majority of Connecticut. Before you select any plant material, determine your hardiness zone using the USDA Plant Hardiness Zone Map 2012 shown at left.



Sun Exposure and Elevation

Grapes prefer full sun exposure for optimal growth and maturity. Vineyards should receive direct sunlight for at least three to four hours a day. In Connecticut (zones 5b-7a), a north/south row orientation would allow for optimum sun exposure. East facing slopes are optimal because the early morning sunshine results in more rapid drying of dew or rain off foliage and fruit (Gladstones 1992). This can reduce disease problems (Rombough 2002). Eastern slopes are more sheltered from the afternoon sun which helps to retain volatile aromatic compounds in fruit and is necessary for converting the carbohydrates in the grapes to sugars.

Elevation can affect vineyard temperature as temperatures tend to decrease with increasing elevation. Avoid steep terrain as it can be dangerous to operate equipment on slopes greater than 15%. Avoid areas near trees because trees can block air flow, increase shade, and may have encroaching root systems that would compete with grapes

for moisture and nutrients. Planting vineyards near bodies of water can help with warming the site earlier in the season and delaying the onset of dormancy in the autumn. In contrast, avoid planting vineyards in the bottom of a valley that may be a 'frost pocket' with have early or late season frosts that can damage plants and fruit.

Soils and Drainage

Grapes can be grown successfully in a wide range of soils. For good root development and general health, grapes require soils with adequate depth, good drainage, a neutral pH (5.5-6.5), and moderate water holding capacity and fertility. Grapes will grow better and withstand drought in soils that are four to six feet deep (Kadir 2004). Maintaining an active earthworm population can help prevent hard pans from forming (Whalley & Dexter 1994).

Grape roots need good soil aeration for proper growth. Poor drainage can increase mortality by decreasing winter hardiness (Heilig 2013). Access can be difficult and also lead to soil compaction if soils are poorly drained. Compacted soils that impede root growth can sometimes be remedied by deep tilling. While general soil maps and information about drainage can be found on the web (https://casoilresource.lawr.ucdavis.edu/gmap/), it is important that you observe the drainage on your site after excessive rain storms.

An easy way to determine soil drainage is to dig a hole about 12" deep. Fill it with water and allow it to stand. If the water is still there the next day, then the drainage is poor and another site should be considered. Moisture requirements vary among cultivars. Red wine varieties can tolerate or even perform better on drier sites, while white varieties prefer higher soil moisture. (Grape Grower's Handbook 2017). While generally not needed for established vines, supplemental watering is guided by rainfall, weather conditions, and observing overall health. The homeowner can use soaker hoses until the vines become established. Sites with excessive soil moisture and fertility will extend vegetative growth past veraison (time of fruit coloring) which will reduce fruit quality and delay the transition into cold acclimation (Brase 2009).

Have your soil tested for pH and fertility before planting and every year thereafter. Details on sampling and processing the soil sample can be found at CAES soil testing. A soil test will give you levels of organic matter along with recommendations necessary to correct any nutrient deficiencies. Soil pH is the measurement of soil acidity (low pH) or alkalinity (high pH). Grapes grow best in slightly acidic soils with a pH of 5.5 to 6.5. This is the range at which soil nutrients are most available (Heilig 2013). Prior to planting, soils with a low pH should be corrected with the addition of lime at the rate indicated by a soil test. It should be incorporated into the soil to a depth of 6-12" due to the time it takes for lime to react with the soil. Most Connecticut soils are acidic and will require additional periodic applications of lime after the initial planting. These additional applications can be applied on the soil surface and do not have to be cultivated into the soil.

Cultivar Selection and planting

In Connecticut, cold-hardy varieties need to be selected. There are many cultivars that are tolerant to the climate and conditions in Connecticut (Ferrandino and Bravo 2016). Selection should be based upon your local climate, planting stock availability, growth habits, and available space since varieties vary in cold tolerance, maturity date, and recommended cultural practices. Some cultivars are more vigorous than others and require different trellising methods. Cultivars are divided into six general classifications for hardiness as outlined in **Table 1.**

Table 1. The range of critical temperatures can vary with cultivar, season, environmental and cultural practices. Some lethal temperatures can overlap in hardiness classes. *Categories most suited for CT (updated from Nail 2006) Cultivars are divided into 6 general classifications for Hardiness as outlined below.

Cold Hardiness Class	Critical Low Temperatures	Species	Some Examples of Cultivars
Tender *	0 to -8^{o} F	Most *Vitis vinifera*	Chardonnay, Cabernet Sauvignon, Gewurztraminer, Pinot gris, Pinot noir, Sangiovese, Viognier
Moderately Tender *	-5 to -10 ^{o} F	Some *Vitis vinifera*, Some hybrids	Riesling, Cabernet franc, Lemberger, Gamay, Chambourcin
Moderately Hardy *	-10 to -15 ^{o} F	Most hybrids	Cayuga White, Chardonel, Traminette, Melody, Norton, Seyval blanc, Vignoles
Hardy *	-15 to -20 ^{o} F	Most *Vitis labrusca native to Northeastern North America*	Catawba, Concord, Delaware, Niagra, Vignoles
Very Hardy *	-20 to -30 ^{o} F	Some hybrids	Frontenac, Frontenac Gris, Foch, La Crescent, Vidal Blanc, Marquette, St. Croix

What are your NEEDS for growing grapes?

Decide if you want to grow grapes for wine, jelly, or table grapes to eat out of hand.
Jam and Jelly cultivars such as Concord, Niagara, and St. Croix (also a wine grape) are readily available. Concord is a prolific producer and resistant to many disease problems.

Table grapes are those grown for fresh eating. There are many cultivars suitable for growing in zones 5b – 7a in Connecticut that can be found in fruit catalogs. At our research farm in Hamden, we have grown Canadice, Himrod, Jupiter and Vanessa with good success. Most table grape cultivars are seedless. Click HERE for further info about table grapes that can be found on our web page #PP032.

***Vinifera* grapes** are more desirable for wine making, but the vines must be grafted onto American rootstock. They tend to yield less, and are more prone to winter injury and disease.

Hybrid cultivars are crosses between two American native grapes (*Vitis labrusca* and *Vitis riparia*) and the European wine grape (*Vitis vinifera*). These plants are more productive and more tolerant of disease and cold weather. Hybrid vines tend to be procumbent, that is, the new shoots tend to hang down in contrast to, *vinifera* vines which tend to grow upright. Hybrid cultivars do not need to be grafted, but when grafted generally have increased yields (Nail 2006). American rootstocks are resistant to Phylloxera, an insect that attacks the roots of European varieties. The scion, the upper portion that bears the fruit, is grafted onto a root stock, the rooted portion of the vine. Therefore, European scions are grafted onto American rootstock. American rootstocks are cold hardy and tolerant of our soils and soil-borne insects and diseases. Without grafting, the desirable European plants only live a few years before the Phylloxera severely damages grape root systems causing severe loss of vigor, decreased yields, and eventually death.

Vinifera grapes should have their graft union (the swollen area on the stem where two plants are grown together) protected throughout the winter by covering the graft union with soil. The soil needs to be removed to below the graft union in the spring to discourage shoots from sprouting from the rootstock. Below is shown a row of VSP

Hilled vines

trained vines (training method discussed below) hilled on both sides to cover graft area for the winter protection. This can be done by hand with a shovel or hoe in a home vineyard.

Personnel and Equipment Access

Spacing between rows should be sufficient for equipment to easily drive through and also should take into consideration the chosen trellising method. See section on trellising as some trellising designs encroach into the row and require wider rows for equipment. Rows can be closer together for smaller home vineyard owners who will only be walking between rows or using a hand cart, small garden equipment, or lawn mower. Plant spacing within a row is generally 6-8 feet apart (Nail 2006). However, this spacing can be reduced if you know you have good soil conditions with proper organic matter, pH, and fertility. This will be reported on your soil test results. This is discussed under trellising methods.

Planting

Vines can be ordered as dormant plants or green growing vines. Dormant vines will sustain less shock at planting time. A week before planting, acclimate your plants by keeping them in the shade. They should be kept moist and in original packing materials (newspaper or wood chips). On the day of planting, the roots should be soaked in a bucket of water until you are ready to plant. Avoid letting the vines dry out which reduces their chances of survival.

Dig a hole in the desired location about 12-18” deep. Fill the planting hole half full of water. Place the vine into the hole to a depth exposing the graft union 4-6” above the soil line (if a grafted cultivar). Back fill the soil and water again to settle the soil around the trunk.

For the first year, trunk shields, growing tubes, or paper milk cartons can be placed around each trunk for protection. These help in protect against weeds and herbicide applications, as well as promoting more rapid trunk growth. Follow your selected training method as the vines grow.

Trellising and Training

No trellis is needed the first year, but it is easier to avoid injuring the vines by installing your wire trellis system prior to planting. All row style trellising systems need a heavy wood post at each end placed 22-30” deep. Posts are usually 4”x4”x8’ made of pressure treated wood, cedar, or spruce. Be sure the post is level vertically with a flat side facing the opposite end of the row. Soil should be packed firmly as the post is back filled. The flat side of the post is drilled with holes for guide and catch wires. The end posts support a lot of weight from the main trellising system to prevent wires from sagging. String lines can be used to insure straight rows if you chose to wait on setting up your trellis. The tall end posts can be placed in the ground as a guide for string placement then later drilled for wire.

A six-foot tall planting post should be set at each vine. The vine is then tied to the planting post to assist in guiding the new plant as it grows until the vine can be caught and attached to the guide/support wire. A planting post is easier to put into place if the trellising system has already been installed because it should weave between the support wires. The wires help prevent it from tipping over. Planting posts can be removed, if desired, once the vine has become mature enough to support itself. Trellising is definitely necessary by the second year after vines are planted. As the vine grows and develops, permanent support is needed for the framework of the cordons (vine arms) and the weight of fruit. If you have waited to install trellis wires until the second year you will need to be

careful to avoid injuring the young tender growth as you run the wire down the row and you will need to lift the vine posts that have been secured to the vine, to be able to weave them through the training wires.

Not expanded

Expanded

If the home grower is planting long rows of vines, additional weight support can be accomplished by adding guide wires beyond the end of the row. One type of weight support, stony ground anchors, is shown to the right (Fenox, photo courtesy of Orchard Valley Supply). This anchor is easy to install and can be added at a later date if extra support is needed. A rod is set with the base pointing at an outward angle away from the wood end post. It is pounded into the soil with a special tool. The rod goes into the soil up to the hook end. Another tool is used to expand the fingers. The metal fingers are forced into the soil securing the rod as seen in the photo inset. The wire cable is attached to the hooks at soil surface and secured to the top of the wood end post. This method works well even if the ground is stony. The tools needed to drive the rod into the soil and to expand the fingers Are reuseable.

If the home grower needs extra support within their rows, additional 8-foot tall support posts can be placed 18 feet apart throughout the row, (approximately every three vines) or as needed where wire sagging is evident. The fruiting wire and catch wires should also be attached to these. These posts are generally made of metal but more expensive wood posts can be used.

Trellising Wire

A Gripple

The wire used as the support or fruiting wire should be sturdy and able to withstand temperature fluctuations and sun exposure. The fruiting wire should be high tensile 12.5-gauge wire. Less heavy wires, such as 14-gauge plastic wire, can be used for catching the canes as they grow and for keeping the vine in a compact form. Heavier wire will stand up better with less chance of being cut when pruning. All wires can be tightened throughout the year without them breaking. If wires become accidently damaged while pruning or are stressed and break, they can be mended using an extra piece of similar material and “gripples” (www.gripple.com). A gripple accepts the wire from both ends and when pulled from opposite ends will allow slack to be pulled up. Gripples are also used at the end of the rows to secure the wire through the post. There are several styles of gripple but the most common one is shown here.

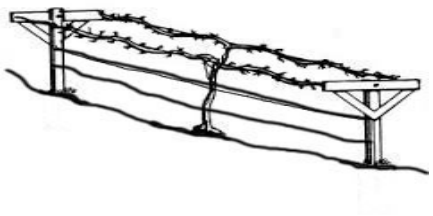
Training Methods

A less vigorous vine is best suited to be trained to **Vertical Shoot Positioning** also known as **VSP.** This is one of the easiest compact training methods. With **VSP**, a main trunk from the vine is allowed to grow to the bottom horizontal support wire of the trellis, which is approximately 30” from the ground. From here two canes or “cordons” are trained to either side of the trunk along the wire. A low “T” structure is formed (Photo - before pruning, from Dr. William Nail CAES). When pruning, select buds that are pointing up.

VSP shoots grow from the primary buds, elongate, and form canes during the growing season. New canes that grow above the structural support wire are then trained through paired catch wires as shown in photo to the left. The paired wires are positioned about 40-42 inches aboveground. An additional pair of wires is positioned about 12-inches above the first pair. These keep the vines upright and tidy. Growth beyond the top two wires is allowed to cascade over or can be trimmed to six inches above the top wires. This trimming process is known as hedging. This method gives the appearance of a candelabrum. It is easy to prune, spray, and harvest and best known by growers.

Hudson River Umbrella

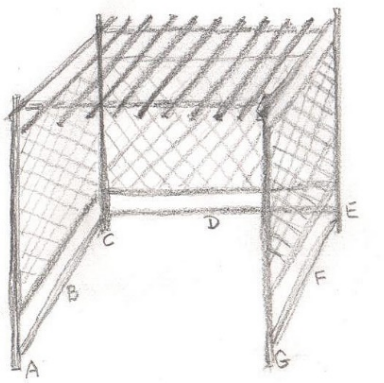
The **Hudson River Umbrella** method, also known as **HRU** is best suited to a more vigorous vine. The **HRU** method is similar to **VSP** but instead of securing the cordon arms to the bottom wire, the trunk is taller and the cordons are trained to the top wire which is about 52-54 inches above the ground and uses the thicker metal wire as support. There is usually one wire closer to the ground about 30 inches that is used to guide or support the trunk. The vine should grow up in front of that wire so prevailing wind will push the vine against the trellis rather than off the trellis. This positioning is true for establishing all vines and must be repeated when using cane pruning designs or replacing damaged cordons. When pruning to the HRU system, buds are selected that point down. Shoot growth is allowed to cascade down freely like an umbrella. Vines grown with this method invade slightly into the path between rows. As the vines mature and increase in length, the vines should be "combed". This is the process of taking your fingers and actually running them down the vine as if combing them. Combing straightens and detangles the canes. Combing increases the ease in harvest and keeps vines closer to the parent plant to make spring pruning easier. After combing, any vines that reach the ground should be trimmed (hedged) approximately six inches off the ground. Distance between rows should be eight feet rather than the six-foot spacing for VSP. The extra spacing prevents shading from the adjacent row, allows better air flow, and improves access for a riding mower.



Geneva Double Curtain

Another method known as **Geneva Double Curtain** or **GDC** is a divided canopy system. A special trellising wire set up is necessary. A low support wire guides the main trunk as in the **HRU**. About 12 inches above the first wire are two separated wires. The trunk passes through these for further support and then divides to go to the outside wires. The divided trunk forms a central V and outside canes grow similar to **HRU**. The outside two wires are parallel and 3-4 feet apart from each other. The wires are attached to 42 inch long cross bars that are supported by posts throughout the row. When pruning to achieve this system, buds are selected that point down as in **HRU**. The inner growth is kept clean allowing sun to reach all four sides. Looking from the end of the row you see a "Y" structure and then a "T" from the sides. This method requires wider rows for access similar to HRU and especially due to the immovable support cross bars going down the row. Allow 8 feet spacing between rows from the ends of the immovable support cross bars to provide access if using a riding mower. Yield from GDC is more than a single width row. It requires a little more training initially and throughout the season to maintain a clean inner "V" area for sun exposure. Harvesting is easy with this method, but generally done from both sides of the row. This method creates the effect of two rows from one row of trunks. Therefore, it can be a good choice for the home growers with limited land. As with the HRU method, GDC vines should also be combed and hedged as needed. Photo above shows an established vine prior to pruning. Harvesting is easy with this method, but due to increased width of the row it may need to be harvested from both sides.

When setting up your wires for your selected training system, keep in mind how you will train the canes. For **VSP** the bottom wire is the single support wire and for **HRU** the top wire is the single support wire. For **GDC** there are two top single support wires. Double wires are for "tucking" the vines in place. When installing these initially, they are separated (one wire on each side of post) and secured to the posts which are 18' apart in the row. This gives a little room for tucking in the canes. C shaped clips or twine can be used to hold these wires together between posts. If you plan on growing only one cultivar, your training method should all be the same to facilitate in ease of maintenance.



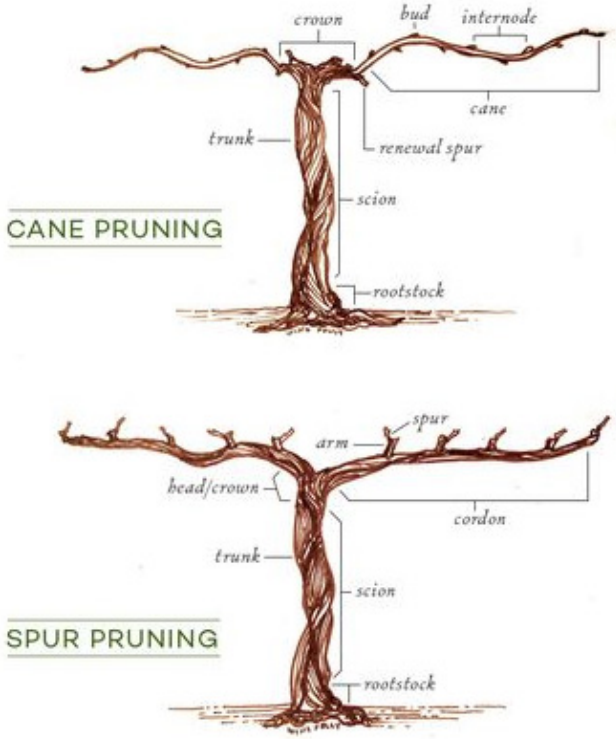
The last method discussed here is an **Arbor or Pergola.** In principal, vines are trained like the Hudson River method, but no wires are used in this method. The trunk is allowed to grow to the top of the trellis structure and remains permanent as with the **HRU** method. The home grower can purchase or build an arbor or pergola that allows for greater grape production with a minimum of yard space. Structures have lattice or small posts attached to four vertical posts to create sides and provide support for climbing vines. Small posts are secured across the top to create a roof that will support vines and fruit.

The vines are planted around the outside edge, trained up the sides, and allowed to grow across the top. Spacing and number of vines is determined by the size of the structure, but is generally the same as the other methods. It is important to allow access to the center of the structure for harvesting clusters hanging from the top. Therefore, one side is left unplanted or with a small entryway. The center shaded area underneath can be used for a picnic table if you have limited backyard space. Along the outside perimeter edges, vines can either trail down like HRU or you can train all growth across the top. Vines that are trained across the roof area allow fruit to hang down and are easy to harvest. Leaf thinning is a little more tedious from under the roof and may require the use of a ladder as most structures are about 8 feet tall. If vines are allowed to cascade down the outside edge, leaf thinning is treated the same as the HRU.

It is important to select a sunny location for this structure as it is difficult to move after posts are installed and the vines have matured. It is also good to orient the opening toward the sunniest direction (preferably south) to increase interior lighting of clusters. Late winter/early spring pruning is done in a similar manner to HRU by leaving the tall trunk and cordons, and then pruning to spurs each year versus cane pruning (see design section below). The excess growth that has grown across the roof is pruned out. Cordon arms are maintained along the outer edges. Cleaning up the old growth from this type of structure can be a little more difficult. The above figure shows a basic idea of the structure. Vines can be planted at A-G in the drawing. Archways can also be used as growing structures with fewer plants. Any vines in Table 3 trained to HRU can be used in an Arbor/Pergola system.

Further Training Designs

There are two major designs used in training. These are **Cane** pruning and **Spur** pruning. These two designs are incorporated after the pruning "structure" has been selected (VSP, HRU, GDC, or Arbor/Pergola). The illustration to right shows cane pruning (top) versus spur pruning (bottom). (Courtesy of Wine Folly Website)



When using the cane pruning design, a new cane is selected each year to replace last year's cordon. A one-year-old shoot (new growth from the previous year) is selected as close to the main trunk and close to the wire as possible. The growth beyond that point, (where the previous cordon was growing along the support wire) is cut off and the one-year-old cane is secured to a horizontal position along the wire. The cane is secured with twine, rubber elastics or C clips. This method provides new clean tissue each year which can reduce disease buildup. It is a good practice to keep a two bud spur, near the main trunk to be used as the new cane for next year. You could alternately leave an additional cane coming from the ground that can be used if any damage occurs to the original trunk. Be certain this cane originates above the graft union or you will end up using root stock! This cane can be removed early in the season if the trunk has shown no damage from the winter. New shoots will continue throughout the season and should be removed. These are called suckers and will be discussed later. By planning ahead for coming years, you can select various shoots for renewal. With cane pruning, you control the vigor by keeping longer canes to be laid down to decrease vigor or shorten the cordon arm to increase vigor. If cordon length is increased, the canes may overlap the next vine's canes. Eventually you will come to a happy medium without your vines and cordons overlapping.

When using the spur pruning design, the vine's structural framework is maintained every year. Instead of pruning off everything beyond the first shoot, the old cordon remains on the support wire and one-year-old shoot growth at each node is trimmed to only a few buds. These little stubs are called spurs. If the vine has been very vigorous, you can leave more than two buds per spur to reduce vigor. To increase the vigor, you should choose just two buds on each spur. The cordon/arms are kept from year-to-year and get larger and woodier. This method is faster to prune, but keeps old wood which may harbor more disease problems.

Very often, when spur pruning, there are multiple shoots coming from a bud. It is important, to retain the shoot originating as close to the cordon/arm as possible. If you just shorten last year's growth and don't maintain a single spur per node you will end up with multiple shoots and overly dense growth. There should be single spurs spaced about a hand width apart on the cordon, approximately five nodes per linear foot of cordon. As the vine gets older, proper spur selection prevent spurs from becoming longer and longer.

Spur selection for VSP pruning

The first photo shows possible shoots to select from when using

the VSP pruning method. The photo to the right shows the remaining spur after selection. The retained shoot originated closest to the cordon. Avoid using "Bull" canes, the thick canes in the center of the left photo, as they are not as fruitful as canes that are of pencil thickness. Both cane and spur pruning are trained the same from this point on.

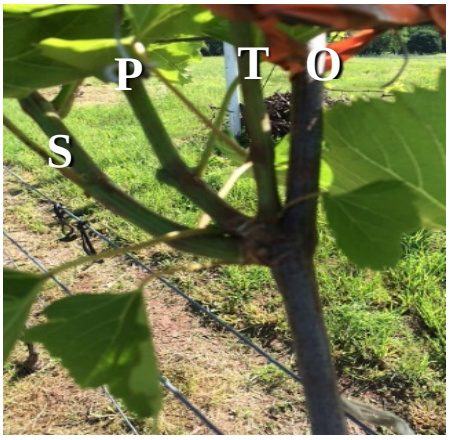
If you are getting a lot of shoots emerging from single nodes during the growing season, you have an overly vigorous vine. To balance the vine and reduce vigor the following year, leave longer cordons in cane pruning or more buds per spur in spur pruning (Winkler et al.1974). Grapes are produced on one-year-old wood; i.e., growth from the previous year.

To summarize, home growers should assess their property to select the method of training best suited to their land and type of grape that will be grown. After selecting the training method, you should decide on the distance between vines and the distance between rows. Distance between vines, varies from 3 to 8 feet and by the vigor of the cultivar selected. Distance between rows is determined by training method chosen and how you will perform maintenance duties (hand or machinery). If you have low vigor vines with good sunlight exposure, then a three-foot spacing is adequate, but will require all work to be done by hand. Vine spacing is a personal preference. You can stretch each cordon of a vine several feet and still get good production. The home grower may plant their rows closer together than is typical for a commercial vineyard since they will be doing their maintenance by hand rather than with large tractors or machinery.

Growth and Maintenance

A grape vine develops new shoots from nodes that are enlarged areas on the old wood (O) of the stem. Each node can contain several buds, but generally will have three. The photo to the left shows three buds that have been allowed to develop into new shoots.

Primary bud (P) - is the largest and produces the major grape cluster production.
Secondary bud (**S**) - will produce about 1/3 to 1/2 of the possible yield of the primary bud, but only if the primary bud is injured or compromised. Sometimes the secondary bud will grow causing an over-abundance of vegetative vine tissue. Thinning may be necessary.
Tertiary bud (T) - only produces vegetative growth. The tertiary bud is still important if winter or mechanical injury has killed the primary and secondary buds. This bud will maintain the growth of the plant creating vegetative stems and leaves, which will produce sugars that sustain the vine growth.



Types of Bud and location

Secondary and tertiary bud shoots may be removed after danger of frost is past if the growth looks too dense and might block the needed sunlight to the grape clusters. Sunlight is needed to produce sugars in the fruit.

Stages of Vine Development and Maintenance

Table 2 provides a general schedule for various vineyard chores. In Connecticut, vines are dormant from November to March. Pruning can be done at any time during this period. Late pruning may provide protection against late frosts by delaying bud growth (Winkler et al.1974). Frost damage usually proceeds from the tip of the cane down toward the trunk. As vines emerge from dormancy and daytime temperatures start to increase, sap begins to flow. The brown sheaths, which protected and covered the buds, fall off. If the vine bases (graft union)

were covered for frost-protection, the soil should be removed now. Pruned material is removed from the vineyard and burned, and any damaged planting posts and wires should be replaced or repaired.

Table 2. Growth and maintenance schedule

Feb/March	April	May	June	July	August	September	October
	Bud Swell	Bloom		Veraison		Harvest	
	Suckering						
			Leaf Removal				
		Tucking and catching with C clips (VSP)					
				Combing (HRU)			
				Hedging			
			Fruit Thinning				
			Fruit set				
Pruning, Training, and Tying			Tying		Netting		

Over several growing seasons, it is possible that the central V above the trunk may have no buds and a blank area without any growth can occur due to bud damage from winter injury. At this point it is advisable to use the renewal shoot (last year's retained sucker) from the main trunk to replace the existing cordon. Another option is to select two canes closest to the trunk that can be crisscrossed and laid down on the wire as the new cordons. This option will immediately fill in the blank area and the old cordon can be trimmed off; thus treating the vine as if cane pruned for one year.

Bud Swell

New Shoots 1/2" to 1"

New Shoots 3-5"

New Shoots 10-12"

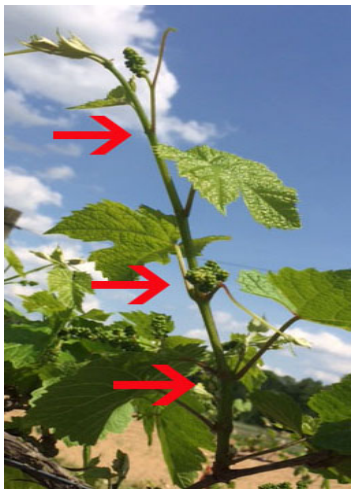
Trace bloom

Bud-break will begin the vegetation growth cycle and new shoots emerge. Plants are most susceptible to frost damage at this stage. See Growth and Maintenance sections above, on the types of buds and how they are affected by frost.

Trace bloom occurs within 6 to 8 weeks of bud break and lasts for 1 to 3 weeks. Flowering begins when the daytime temperatures reach approximately 60-65° F. An early flowering usually signals a very good quality vintage (Jones and Davis, 2000). Warm calmer weather is optimum for the vine growth. Rain or destructive hail can be disastrous now by damaging flowers or encouraging disease.

Vines can produce clusters the first year of planting, but clusters should be removed to promote strong vegetative vines. This will push the energy into the vine and roots, and not fruit production. The third year you can harvest a crop. Clusters of *Vitis vinifera* form at the 2nd and 3rd (occasionally 4th) buds so the training method will determine

where you will be harvesting your clusters. French American Hybrids tend to flower more prolifically than *Vitis vinifera* and can produce four or more clusters per shoot. These are generally located between the third to sixth node on the shoot.



Vitis vinifera fruiting clusters

After flowering, the shoots remaining after thinning can be trained between the structure wires. Care should be taken with young shoots as they are tender and easily snap. This process can be delayed until the canes have hardened off and become less tender. A few weeks later, the blossoms are replaced by tiny berries that will grow in size, but remain green and hard.

Suckers are excess growth from the base and main trunk of the vine (basal suckers) or at the area where shoots attach to the cane (lateral suckers). Basal suckers are removed from the trunk as they emerge, about every week and a half to decrease competition with the main vine. Lateral suckers may be retained unless they cause shading of fruit. Removing suckers helps maintain the pruned structure, reduces possible disease infection, and reduces areas that harbor insects.

The base of vines should always be kept cleared of excess cane growth. Any growth forming on the trunk below the graft union should be removed. No more than one or two trunks with one renewal (strong basal sucker above graft union) is optimal. Tie this “renewal” to the trunk for support and to prevent it from getting damaged. The photo to the left shows the renewal canes with additional suckers along the trunk. The photo to the right shows the final retained renewal cane. The renewal cane is used the next year if damage has occurred to the main vine over the winter. Or can be pruned off at the beginning of the season. New renewals that grow throughout the season should be pruned out retaining one shoot for next years consideration.

After the berry clusters have begun to form, remove some leaves from around the grape clusters to improve air circulation and reduce the possibility of bunch rot. Thinning leaves on a vine can initiate additional shoots to sprout from the nodes (lateral suckers). This can also happen when vines with larger root systems are pruned to a few nodes. These extra shoots/suckers can be snapped off if they make the area around clusters too dense or hard to manage. Do not strip off “all” the leaves in the fruit zone. Leaves are needed to produce the sugars you want in the grapes. Allow a “dappling” of sun with mild shading. Over thinning can cause sun scald on fruit. Do not practice leaf thinning until vines have produced clusters and discontinue prior to veraison. Continued thinning can weaken the vines and the subsequent fruit will be of an inferior quality.

Before and after thinning

Long shoots protruding over the top wire in the **VSP** method, can be trimmed (hedged) every two to three weeks to concentrate vine metabolism on the fruit and maintain vineyard tidiness. When hedging a vine that is cane pruned (vs. spur pruned), think ahead to next year. Remember that "short" shoots are not desired as one of them will be the cane you lay down on the wire next year as your new cordon. If canes were trimmed too short while hedging, you do not have the option to increase or decrease vine vigor by adjusting the cane length.

Mid-Summer starts **Veraison**, the onset of ripening as the grapes begin to soften and swell significantly. Veraison normally occurs in August in Connecticut, but varies slightly with cultivar. White varieties turn translucent and purple varieties gain color. The grapes now increase in sweetness as sugar is transported from the leaves into the fruit. Flavor compounds and tannins also begin to increase. Berries swell from increased water content which dilutes the concentration of the acids. No additional leaf thinning should be done from this point onwards. This is also the time for diligent bird control in the vineyard.

Start of veraison

Mature fruit

As the fruit matures, make daily observations in the vineyard. If there is an over abundant crop or a lot of unevenly sized berries within the clusters (hens and chicks), these clusters can be removed to improve the quality of remaining clusters. Sometimes clusters will form outside the desired fruiting zone and these can also be removed. As grapes continue to ripen, sugar, color, and pH increase as total acidity decreases. Grapes need to develop aroma and taste characters. This results from berry maturity and correct sugar to acid balance

Soon sugar levels should be evaluated in anticipation for harvest. For the average home grower, the most important factor is the taste. Sugar levels should be between 19 to 25 degrees Brix. This can be measured with a hand held refractometer as shown in photo to the right (from WineMaker Magazine). This tool measures the amount of sugar in the grape berry flesh. Sampling should include many berries to get a representative sample as the berry position within a cluster, location of the cluster on the vine, and location of vine in the vineyard can drastically change the reading results.

Netting

Netting is generally done once the grapes have reached Veraison. Birds are more attracted to grapes when they are coloring as they are more easily seen and the sugars are increasing. There are several ways you can protect your vines with netting. The two most common methods are **Side netting** and **Over the top netting**. If using the VSP training method, then side netting is easiest. When training to HRU, GDC, pergola or an arbor it is easier to use the over the top method.

Side netting

Side netting involves netting both sides of the row at the fruiting zone. The net is closed at the top and underneath with clips or clothes pins. The drawback to this method is that it is very time consuming and birds can get inside the net if not enough clips are used. The nets sometimes are very close to the fruit clusters. Birds will just land on the net and eat though the net holes. Shading of the clusters can increase when the netting is drawn tight in order to clip them together. Side netting is most often used with the home vineyard where only a small number of vines need to be protected.

Over the top netting uses a wider net and is more suited for use with cascading training systems such as the HRU, GDC, pergolas, and arbors. In large operations, several rows can be netted in one operation as shown below. Having an upper guide wire (outside photos below) helps to keep the netting off the vines and prevents growth into the net. Vines growing into the netting make it difficult to remove the netting after harvest. Over the top netting is secured at the ground by stapling it taut with metal staples that are flagged for easy removal. Stapling to the ground provides more room for the cascading shoots than when clipping directly below the fruit zone. Harvest is easier when netting several rows since you don't need to unclip the netting to access the clusters.

Over the top netting

Weed Control

Controlling weeds under the vines decreases competition for nutrients and water, and also reduces insect and disease problems. Herbicide applications or mechanical control will be needed throughout the growing season to maintain a weed free zone. The photo above, taken in the spring, shows the difference in rows that were treated with a fall herbicide application and those not treated. An end-of-season season weed control can be applied after the vines have gone dormant and lost their leaves. This helps to prevent vine damage from pesticide drift. Growing tubes on newly planted vines also helps prevent this damage. Check the label on herbicides to be certain they can be used around grapes.

Harvest

For the home grower, with no equipment to test your grapes, clusters should be completely colored. Berries should pull off of stems without too much effort. The seeds should come away from the pulp easily. Juice should be sticky to the feel and the grapes should taste good.

Brix (also known as Balling) is the measurement of sugar content represented as grams of sugar per 100 grams of juice. It can be measured using a hand held refractometer in the field or a floating hydrometer in the winery. If your grapes have a reading under 20 Brix the sugar levels are too low and they may not be ripe enough for harvest. If fruit is close to harvest quality and rain is forecast, it is advised to harvest prior to rain. The sugar content will drop after a rain storm. For Basic Guidelines on Winemaking see our fact sheet on our **web page**.

End-of-season

After harvest in the fall, vines stop growing and go into dormancy as temperatures decrease. Vines go through three stages of dormancy.

Acclimation: The first stage of dormancy. Vines no longer have their fruit crop. Growth ceases. A period of cool weather is required before vines lose their leaves.

Mid-winter Dormancy: This is the second stage of dormancy which occurs during the mid-winter months. Vines obtain their maximum level of cold hardiness.

De-acclimation: This is the third stage of dormancy. Vines start to adjust to temperatures warming above 32 ^{o} F. The ability to break dormancy also depends on the level of stored carbohydrates in the vines.

Vines can go back and forth between stages two and three. It is this back and forth transition that can cause winter bud damage. Spring pruning should be delayed until this threat has passed so that you can better assess winter injury and adjust your pruning. Rough pruning is the only type of pruning you should do before spring pruning. Rough pruning includes removing the majority of last season's growth, but maintaining several buds. Since frost damage proceeds from the tip down, rough pruning leaves some tissue that can be removed later if further frosts damage the terminal buds. After the period of damaging winter injury temperatures has passed, the final cleanup pruning can be done, making final bud selections.

Table 3 is an edited list of cultivars that we have grown on our research farm. Only the two most common training methods were used at this vineyard. The harvest timings are only estimates and can be influenced by the particular growing site. Some cultivars may be trained to several different structures but the listed methods have been found to be optimum for their growth habit.

Table 3 Vine Grape Cultivars suited to Connecticut

Cultivar	**Fruit color**	**Parentage**	**Harvest Timing**	**Training Method**
Aromella	White	French-American Hybrid	Mid	HRU
Auxerrois	White	*Vitis vinifera*	Mid/Late	VSP
Brianna	White	French-American Hybrid	Early	HRU
Cabernet Franc	Red	*Vitis vinifera*	Late	VSP
Cabernet Sauvignon	Red	*Vitis vinifera*	Very Late	VSP
Cayauga White	White	French-American Hybrid	Early/Mid	HRU
Chambourcin	Red	French-American Hybrid	Late	HRU
Corot Noir	Red	French-American Hybrid	Mid/Late	HRU
Frontenac	Red	*Vitis riparia - based*	Mid/Late	HRU
Frontenac Gris	White	*Vitis riparia - based*	Mid/Late	HRU
Gamay	Red	*Vitis vinifera*	Early/Mid	VSP
Gruner Veltliner	White	*Vitis vinifera*	Mid	VSP
La Crescent	White	*Vitis riparia- based*	Mid	HRU
Lemberger	Red	*Vitis vinifera*	Early/Mid	VSP
Marquette	Red	*Vitis riparia - based*	Early	HRU
Merlot	Red	*Vitis vinifera*	Mid	VSP
Noiret	Red	French-American Hybrid	Mid/Late	HRU
Petit Mansang	White	French-American Hybrid	Late	VSP
Pinot Blanc	White	*Vitis vinifera*	Mid	VSP
Pinot Noir	Red	*Vitis vinifera*	Mid	VSP
Riesling	White	*Vitis vinifera*	Late	VSP
Rkatsitelli	White	*Vitis vinifera*	Mid	VSP
St. Croix	Red	*Vitis riparia - based*	Early	HRU
Syrah	Red	*Vitis vinifera*	Mid/Late	VSP
Traminette	White	French-American Hybrid	Late	HRU
Vidal	White	French-American Hybrid	Late	HRU

Disease and Insects

It is important to be vigilant and make frequent observations in the vineyard for insect and disease problems. At least once a week, it is good to walk the vineyard and observe what is happening. Diseases should be handled in a prophylactic manner, i.e. as a preventative rather than as a cure. Once a disease is observed it is many times too late to apply a spray.

Major Diseases that Affect Grapes

Fungus

Powdery Mildew (*Erysiphe necator*, aka *Unicinula necator*)
Spores overwinter on the trunk and disease initiates between bud break and bloom. It is most severe in shaded regions of the vine. It grows best at temperatures near 80° F and will start to die at temperatures above 95° F. Leaf removal around clusters at fruit set helps reduce the severity of infection. Growth of the fungus can occur on both the lower and upper leaf surface and looks powdery. For more information: Powdery Mildew of Grapes Jan 2016

Powdery mildew of upper leaf, lower leaf surfaces, and advanced (left to right)

Downy Mildew (*Plasmopara viticola*)
This disease persists in the soil as resting spores that originate within infected leaves and berries. Rainfall and temperatures above 52° F are needed for infection initiation. It can infect berries, leaves, and young shoots. Leaf lesions appear as yellow or reddish-brown areas on the upper leaf surface with corresponding white downy, or cottony fungal growth on the lower surface. For more information: Downy Mildew of Grapes Feb 2016

Downy mildew on upper (l) and lower (r) leaf surfaces

Phomopsis (*Phomopsis viticola*) also called dead arm disease)
This fungus builds up on dead canes or pruning stubs. Infected rachises and shoots develop black lesions that may split shoots and appear sunken on rachises. Small pinprick sized lesions, with brown or black centers, are surrounded by small often yellow margins in early season. The disease is favored by cooler weather. Spots appear several weeks after rain when shoots begin growth after bud break.

Phomopsis on upper leaf surface and on new stems

Black Rot (*Guignarda bidwellii*)
Overwinters in mummified fruit on vineyard floor. Initial infection occurs 2-3 weeks after bud break during wet periods. Spores ooze from fruiting bodies and are distributed by raindrops onto susceptible tissue. For more information: Fact Sheet PP020 (11/03R).

Black rot on upper leaf surface, lower leaf surfaces, and on fruit (left to right)

Eutypa Dieback (*Eutypa lata*)
Spores are spread by wind and affect freshly pruned wood. Symptoms do not usually become evident for 2-3 years. They appear as cankers on trunks and cordons of infected grapevines. If these are cut, a wedge shaped discoloration of the wood is seen. New growth appears stunted with short internodes and cupped foliage. Healthy shoots usually overgrow infected shoots by midsummer but leaf and shoot tissue become increasingly worse each season and tissue above the canker eventually dies.

Eutypa Dieback

Anthracnose (*Elsinoe ampelina*)
It is most prevalent in rainy, humid, warm regions. Lesions can occur on all parts of the plant, but are most prevalent on shoots and berries. They first appear as numerous small circular reddish spots, then enlarge, become sunken and produce lesions with gray centers and round angular spots. Dark reddish brown to violet black margins eventually surround the raised lesions. Necrotic areas on leaves often form lesions that drop out. Control: sanitation, elimination of wild grapes, canopy management, and fungicide use. For more information: Grape Anthracnose Feb 2016. (Photos credit: Dr. Frank Ferrandino, CAES)

Anthracnose on leaves and fruit

Botrytis (*Botrytis cinerea*)
It may affect blooms, leaves, and shoots. It is manageable by cultural and chemical controls. Select your growing site by avoiding fog areas, manage canopy density by leaf thinning, shoot positioning, and pruning. Avoid excess nitrogen. Botrytis bunch rot occurs principally when it rains near harvest. Dense shaded canopies encourage the development of this disease. It is also called Gray mold and 'noble rot". Sometimes the disease is cultivated to create natural sweet and highly aromatic wines.

Botrytis

Bacteria

Crown Gall (*Agrobacterium vitis* Ophel & Kerr 1990)
This disease has characteristic symptoms of fleshy to woody galls produced mostly on the lower trunk near the soil line. It restricts flow of nutrients and sugars. It is thought to be associated with wounds to the trunk caused by frequent freeze thaw cycles or mechanical damage. When the galls completely encompass the trunk, any growth beyond that point dies.

Bacterial crown gall

Viruses

Grapevine Red Blotch (associated *GRBaV*)
Plants become stunted, leaves prematurely red, eventual death of vine. (photo credit: Ontario Ministry of Agriculture, Food and Rural Affairs)

Grapevine red blotch

Grape Leafroll (*GLRaV*)
Delayed fruit maturity, poor color, reduced yields. On red fruited cultivars in late July or early August as the crop nears veraison, the leaves exhibit red and reddish-purple discoloration in the interveinal areas of mature leaves near the basal part of the shoots. These symptoms progress to upward leaves as the summer progresses. By later season red fruited cultivars consist of green veins and reddish interveinal areas. White cultivars express symptoms differently if at all. In some cultivars, infected leaves may show general yellowing or chlorotic mottling toward the end of the season. In some cases, leaf margins may roll downward. It has been concluded that Vine Mealy Bug (*Planococcus ficus*) is the causal vector for the virus (Sweet 2008). The virus can be confused with Phosphorus deficiency. (Photo credit: Daane et al. 2002) For more information: Grapevine Leaf Roll.

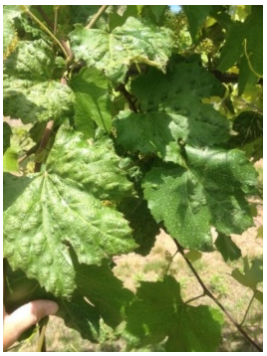
Grape leafroll, The photo on right photo shows winged adult male Vine mealy bug with a female to his right.

Sour Rot
Sour Rot is caused by various microorganisms including acetic acid bacteria, yeast, and fruit flies. It is also called bunch rot. This condition develops at the beginning of veraison and when Brix levels have exceeded 8 degrees. Vine canopies can be thinned along with fruit thinning. Tight clustered and thin-skinned varieties are more susceptible and also fruit that has been damaged by birds. Infected clusters smell like vinegar when you walk by. High fruit fly populations significantly aide in the incidence of this disease and its spread to other vines. Low wire training such as the Vertical Shoot Positioning, (VSP) provided better conditions for growing than the Hudson River Umbrella (HRU) method, which creates more humidity around the clusters (Wines & Vines .2018).

Sour rot

Major Insects that Affect Grapes

Erineum Mites (*Colomerus vitis (Pagenstecher)***)**
In established vines, this mite is not considered a problem that needs to be treated, but in young vines the vigor can be affected. An early application of sulfur may help (Battany 2016). Dormant oil sprays may also assist in protection. Images below show both the upper and lower views of infected leaves.


Upper leaf surface, lower leaf surface (l to r)

Phylloxera (foliar Phylloxera, *Daktulosphaira vitifoliae* (Fitch))
The insect overwinters in the egg stage on canes. After hatching eggs are deposited into leaves resulting in deforming galls about the time when the 5th leaf expands. Root galls cause stunting and eventual death of "European grape varieties". There are many generations of this insect each season. Root infestations can have many life cycles without seeing foliar infection, but foliar infections only occur if there is a root infection (Bessin 2003). American grape varieties, European hybrids, or European varieties grafted onto American rootstock are "tolerant" to the root gall form of the insect. Some cultivars are resistant to root galls, leaf gall or both. That is why you may have one vine that is infected and the next vine of a different cultivar is clean. (photo lower surface)

Foliar Phyloxera

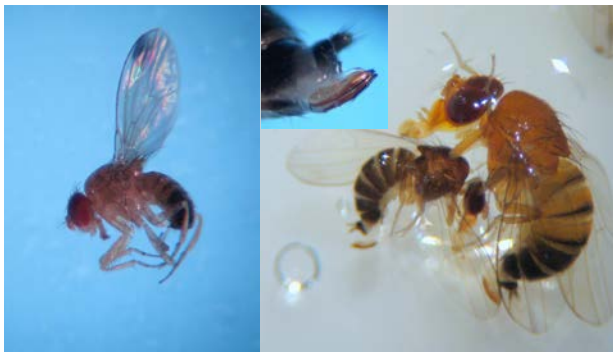
Grape Berry Moth (*Paralobesia viteana* (Clemens))
Berry moths over winter as pupa in vineyard leaf litter. The first generation emerges just prior to bloom. They mate and females lay eggs on the fruit clusters. Larvae hatch, from eggs in about 3 to 6 days, and burrow into the newly developing fruit. The damaged fruit is hollow in appearance. It is then susceptible to infection by botrytis and sour rot and can attract fruit flies, wasps and ants. There are 2-3 generations in this pest's life cycle. Keep an eye open for egg masses and larvae in mid to late July. Adult (Photo credit: J. Ogrodnik, Cornell University)

Grape berry moth

Grape Cane Gallmaker (Ampeloglypter sesostris (LeConte))
This pest creates red elliptical galls on the canes. You can get good control if galls are removed and burned by mid-July (before the adults exit the gall). The vine is still capable of producing a crop even with this damage and generally insecticides are not needed. (Photo credit: Ric Bessin, Univ. Kentucky)

Grape cane gallmaker

Spotted Wing Drosophila (Drosophila suzukii)
Only males show the spot on their wings. Both male and female infest several dozen cultivated plants, but have more potential damage to thin skinned fruits. Grapes are not the preferred host but it is becoming more common to see this insect in the vineyard. (photo credit: Dr. Richard Cowles, Valley Lab, CAES) Spotted Wing Drosophila fact sheet



Spotted Wing Drosophila

Japanese Beetle (*Popillia japonica* (Newman))
Japanese beetles can do a lot of damage on grape leaves starting in late June. The leaves can become lacy in appearance with areas between the veins being chewed out completely. This can be serious as large amounts of leaves are needed to produce the nutrients needed by the fruit. Usually, the damage is not extensive in the vineyard. Japanese beetle fact sheet EN027

Cane Girdler (*Ampeloglypter ater* (LeConte))
This is a small black weevil about 3 mm long. The insect is similar to the Cane Gallmaker but the girdler is black while the Gallmaker is reddish. The cane will fall off beyond the insect girdled area. Generally this is not a big issue as girdling takes place beyond the fruit zone. The insect eggs are in the fallen tissue. Small red arrow shows damage to stem.

Cane Girdler

Brown Marmorated Stink bug (Halyomorpha halys Stal, 1855)
The Brown Marmorated Stink Bug can cause damage to developing fruit. Feeding results in necrotic spots on the berries. Incidence of Sour Rot can increase especially where fruit has been damaged by the Spotted Wing Drosophila. Highest populations occur in August through October. White varieties are more susceptible than red varieties. (Nielsen, et al. 2016) Wine can be tainted with the presence of BMSB. Brown Marmorated Stink Bug factsheet

Brown Marmorated Stink bug

Other abnormality's (for your awareness but generally not an issue)

Cranberry galls on lower (l) and upper leaf surface (r).

Gallmakers possibly Grape Tumid Gallmaker (*Janetiella brevicauda*)

Any pesticide usage should be verified for your area and should be labeled for use on grapes. More detailed description of insect and disease life cycles can be found in Nail (2007) *Grapevine Cultivation in Connecticut,* and Wolf and Boyer (2003) *Vineyard Selection*.

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