

Karime Assis: *Vitis vinifera*

Vitis vinifera L.

Monograph

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1.0 Chapter 1: Introduction

Grapes are known all around the globe for their various uses and values. They are known for their international flavor and their products. Viticulture is the science, generation, and thinking of grapes. It deals with the arrangement of occasions that happen within the vineyard. *Vitis vinifera* is full of nutrients and minerals, they could protect against cancer, eye problems, cardiovascular disease and many other health conditions. *Vitis* includes a nutrient called *Resveratol* which can contribute to many health benefits. This fruit is considered an excellent source of fiber and potassium.

These tiny semi shaped spheres are consumed in different ways such as, raw, dehydrated (raisins) and it's most popular among all, wine. Wine is considered one of the most famous alcoholic beverages around the world. Wine is a drink that is made out of juiced grapes. This goes through an alcoholic fermentation which is produced by the action of yeasts added to the grape juice. These yeasts transform the natural *Vitis* sugars into ethanol and gas into CO_2 .

Throughout this monograph there are four chapters which are rich in information about *Vitis vinifera*. The first chapter is focused on the ecology of the species, specifically its environmental factor. The second chapter is then focused on the biology of *Vitis Vinifera* which informs about the biological structure and the organism of the grape. The third chapter is about propagation and management of *Vitis Vinifera* which talks about the process of cultivation. Finally, the fifth chapter talks about the grape and wine production and distribution. This fantastic fruit is one that is globally recognized for its many uses and its impact on global economies and agricultural sectors. Its historical impact and importance can be traced back further than to ancient Egypt, and its presence in our diets and homes is one that adds several nutritional benefits to our systems.

The overall impact of *Vitis vinifera* is one that is difficult to measure globally but regardless, its effect on global food chains has been massive to many different nations. This monograph will highlight the importance of this product and highlight its biological components.

2.0 Chapter 2: Ecology

2.1 Affinity and Origin

The Middle East is known as the "homeland of grapes," and *Vitis vinifera* production originated there between 6,000 and 8,000 years ago. Yeast, one of the first domesticated microbes, grows naturally on grape skins, leading to the development of alcoholic beverages such as wine. The oldest archeological evidence for winemaking's predominance in human society may be found in Georgia, dating back 8,000 years. Violet grapes were cultivated by the ancient Egyptians, and history confirms that the ancient Greeks, Cypriots, Phoenicians, and Romans grew purple *Vitis* for both consumption and wine making. *Vitis vinifera* cultivation would gradually expand to other parts of Europe, as well as North Africa and, lastly, North America (Kadri et al., 2019). The grapevine has been cultivated since antiquity; according to drawings on old vases, it was widely farmed in Crete, and it was from Greece that they were first transported into Italy. The grape was brought to Europe by the Romans. This is the "old world grape," often known as the "European grape," which accounts for more than 90% of global output. The grapevine, *Vitis vinifera*, is not a particularly pure species. There are approximately 100 species of the *Vitis* family (*Vitaceae*) in the literature, roughly 60 of which are regarded to be genuine species and more than 40 of which are doubtful (probably hybrids between different species, many of them are very indistinct from each other). *Vitis* is nearly exclusively indigenous to the Northern Hemisphere, and it is plentiful throughout North America. (*Vitis vinifera* L., 2015.)

Figure 1: Taxonomy and Nomenclature:

Taxonomy and Nomenclature	
Kingdom:	Plantae
Taxonomic Rank:	Species
Synonym(s):	
Common Name(s):	wine grape [English]
Taxonomic Status:	
Current Standing:	accepted
Data Quality Indicators:	
Record Credibility Rating:	verified - standards met

(ITIS - Report: *Vitis Vinifera*, 2022)

https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=28629#null

Figure 1.2: Taxonomic Hierarchy:

Taxonomic Hierarchy	
Kingdom	Plantae – plantes, Planta, Vegetal, plants
Subkingdom	Viridiplantae – green plants
Infra kingdom	Streptophyta – land plants
Supradivision	Embryophyta
Division	Tracheophyta – vascular plants, tracheophytes
Subdivision	Spermatophytina – spermatophytes, seed plants, phanérogames
Class	Magnoliopsida
Superorder	Rosanae
Order	Vitales
Family	Vitaceae – grapes
Genus	Vitis L. – grape
Species	<i>Vitis vinifera</i> L. – wine grape
Subspecies	Direct Children: Vitis vinifera ssp. sylvestris (C.C. Gmel.) Hegi – wild grape

(ITIS - Report: *Vitis Vinifera*, 2022)

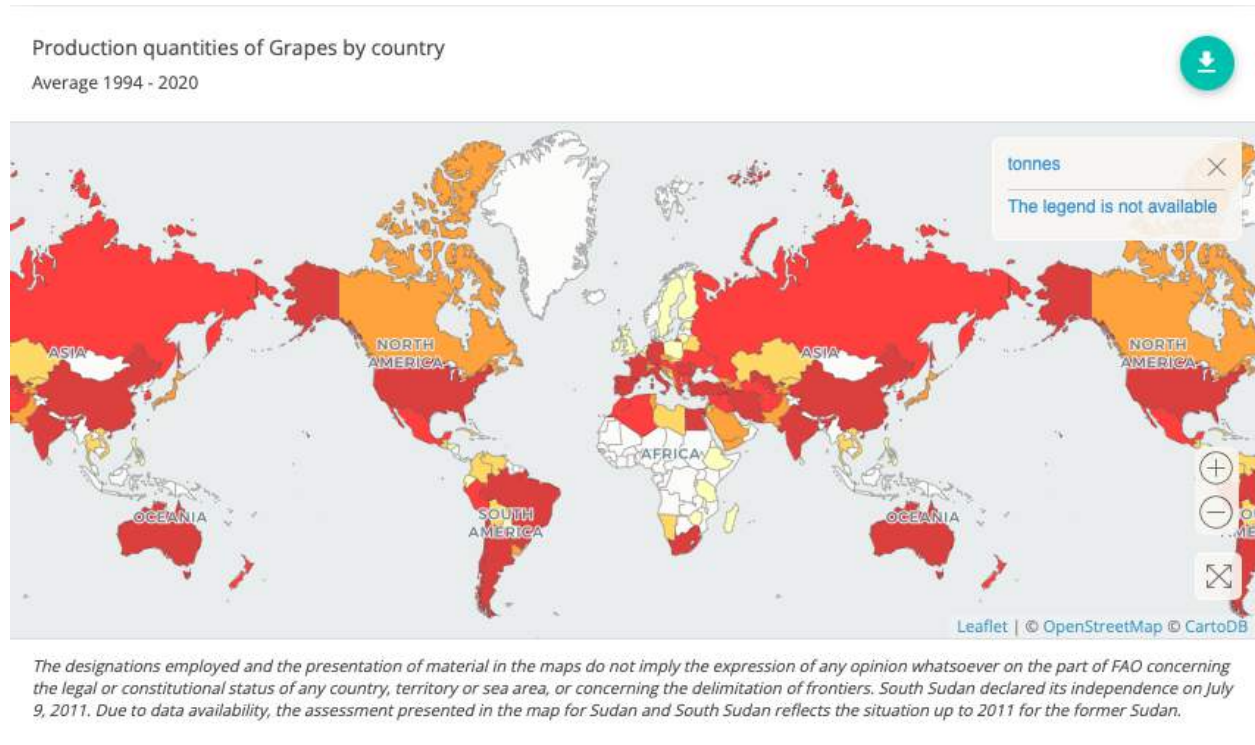
https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=28629#null

2.2 Distribution

The grapevine is native to an area that reaches from north-east Afghanistan towards the Black Sea and Caspian Sea's southern boundaries. Around 4000 BCE, it was developed and there expanded towards the Mediterranean Basin, Western Europe, India, China, and Japan. Europeans were the first to bring the grapevine to the Americas. It is now grown all over the world. It crossed with native *Vitis* species in certain cases, resulting in cultivars that were suited to local circumstances. The grapevine is cultivated in both hemispheres, primarily between 20 and 50 degrees north and south. It may be found growing between 300 and 2000 meters above sea level in tropical climates (Çetin et al., 2011). *Vitis vinifera* is recognized all around the world. In countries such as the United States, Brazil, Argentina, Chile, Australia, China and the European region, grapevine production is very strong. In countries such as Canada, Colombia, Venezuela and Turkey its production is not very common, there is a small percentage but not largely. Distribution in Malaysia and most of Africa is non-existent. For *Vitis vinifera* production to be successful it has to have special qualities, such as climate, soil, water percentage and humidity levels. Countries such as the United States, Brazil, Argentina, Chile, Australia, China and the European region are rich in these qualities. This data is from the year 1994 to 2020. At least throughout the western half of the Mediterranean Bowl, the wild grapevine's current distribution is highly divided, with few humans living in disconnected micro-populations or metapopulations. Anthropogenic pressure on their natural habitats, as well as viruses introduced from North America in the late 1800s, may explain the population decline of wild grapes. The 'Phylloxera catastrophe,' which afflicted European vineyards, had a major impact on

both established and wild *Vitis* varieties. As a result of the termination, advanced wild grapevines are endangered and weakened. *Vitis vinifera* subspecies, *Sylvestris* has a large stake in biodiversity conservation in the long run. (FAOSTAT, 2020.)

Figure 2: Current distribution of *Vitis vinifera* Visual



“Grape.” *Encyclopædia Britannica*, Encyclopædia Britannica, Inc.,
<https://www.britannica.com/plant/grape>.

2.3 Elevation and Climate

The climatic effects of a particular location go a long way in affecting the type of *Vitis vinifera* varieties planted in a region and the sort of viticultural methods that will be utilized, in addition to determining whether or not viticulture can even be sustained in that area. During the growing season, appropriate light, heat, and water are all necessary for the proper growth and development of *Vitis vinifera*. Furthermore, studies have provided additional insight on the impact of rest, which happens after harvest when the grapevine effectively shuts down and saves its energy for the start of the growth cycle the following year. *Vitis vinifera* crops flourish in temperate areas that provide extended, warm periods throughout critical blooming, fruit set, and ripening times. When temperatures hit approximately 10 °C (50 °F), several grapevines' physiological processes begin. The vines normally go into hibernation at temperatures below

this. The vines can be severely damaged by frost at temperatures below this limit, such as 0 °C (32 °F). The vine will begin flowering when the average daily temperature is between 17 and 20 °C (63 and 68 °F). When temperatures reach 27 degrees Celsius (80 degrees Fahrenheit), many of the plant's physiological processes go into high gear, and *Vitis* clusters begin to mature on the vine. The quantity of rainfall (and the necessity for extra watering) is another distinguishing attribute, in addition to temperature.

During the growth season, a grapevine requires around 710 mm (28 in) of water, not all of which can be delivered by natural rainfall. During the growth season, the environment in the Mediterranean and many continental regions may be relatively dry, necessitating supplementary watering. Maritime regions, on the other hand, frequently experience the opposite extreme of excessive rainfall throughout the growing season, which brings its own set of viticultural challenges. (“Climate Categories in Viticulture,” 2021) During the growth season, sufficient sunshine, heat, and cold are essential for producing strong vines. Grapevines do best in locations that have long, hot summers and moist winters. Warm weather allows grapevines to blossom, set fruit, and mature during the growing season. Grapevines, depending on the growing location and *Vitis* type, require a range of 1390 to 2220 growth degree days (temperatures over 10°C) to mature adequately. Water is required for the growth of a grapevine. Some parts of the world get enough rain to keep *Vitis* vines alive, while others need to be watered. Climate, heat, soil, wine type, and other factors all influence how much water grape vines require. The growth of *Vitis* is influenced by environmental conditions (“Climate Categories in Viticulture,” 2021).

2.4 Geology and Soil

Table 1: Types of Soil

Soil type	Notes
<i>Sandy soil</i>	Sandy soils are useful when retaining heat because of their large particles. This type of soil is very useful when it comes to regions where there are humid/wet climates but it is not useful in regions where there is no humidity (droughts). A positive aspect would be

Table 1: Types of Soil

Soil type	Notes
<i>Clay soil</i>	<p>how this specific type of soil retains heat and reduces the amount of moisture reducing the chances of the plant getting diseases. This soil can also cause dehydration to the plant but will make it more resistant to louse phylloxera from attacking it. (<i>Soil Types That Matter For Grape Growing</i>, 2019.)</p> <p>Regions with this specific type of soil: Bordeaux’s Medoc and Graves</p> <p>Species susceptible: Zinfandel, Cabernet Sauvignon</p>
<i>Loam soil</i>	<p>Clay soil is the opposite to sandy soil. This specific type of soil is made up of very small particles. These particles help maintain moisture for a long period of time. When the soil retains moisture to <i>Vitis vinifera</i> it helps benefit it. (<i>Soil Types That Matter For Grape Growing</i>, 2019.)</p> <p>Regions with this specific type of soil: Barossa Valley, Pomerol</p> <p>Species susceptible: Sangiovese, Merlot</p>

Table 1: Types of Soil

Soil type	Notes
	<p data-bbox="561 401 1016 453"><i>Matter For Grape Growing, 2019.</i>)</p> <p data-bbox="561 506 1421 600">Regions with this specific type of soil: Sonoma Valley, Napa Valley</p> <p data-bbox="561 653 984 705">Species susceptible: <i>Pinot Noir</i></p>
<i>Volcanic soil</i>	<p data-bbox="561 831 1421 1220">Volcanic soil has an origin of a past volcanic eruption. This type of soil is very thin and is good at retaining and reflecting heat. It is also very good at draining and holding water moisture. Volcanic soil can be rich in minerals that can help <i>Vitis vinifera</i> be strong and nutritious, these components are: iron, calcium, magnesium and potassium. It is important to know that not all volcanic soils have a positive impact towards the plant species. (<i>Soil Types That Matter For Grape Growing, 2019.</i>)</p> <p data-bbox="561 1272 1040 1314">Regions with this specific type of soil:</p> <p data-bbox="561 1367 805 1419">Sicily, Santorini</p> <p data-bbox="561 1472 1268 1524">Species susceptible: <i>Assyrtiko, Nerello Mascalese</i></p>
<i>Limestone</i>	<p data-bbox="561 1598 1421 1860">Limestone has a very good impact towards <i>Vitis vinifera</i>. Limestone soil is composed out of decomposed bodies of fish and organic material. Limestone is very useful when it comes to drainage in wet weather but may retain water in dry weather, helping the plant maintain its nutrients. Limestone has a high pH</p>

Table 1: Types of Soil

Soil type	Notes
<i>Silt soil</i>	<p>level helping sunlight to reflect on the vine and help promote photosynthesis. Its fruits are most likely to be acidic because of its high pH level. (<i>Soil Types That Matter For Grape Growing</i>, 2019.)</p> <p>Regions with this specific type of soil: Burgundy, Champagne</p> <p>Species susceptible: <i>Pinot Noir, Sauvignon Blanc, Chardonnay</i></p>
<i>Silt soil</i>	<p>Silt soil that's a fine texture. It has a good water and moisture retention property due to its small particles. Even though retention can be a positive aspect towards <i>Vitis vinifera</i>, it can cause diseases since it can cause water logging. (<i>Soil Types That Matter For Grape Growing</i>, 2019.)</p> <p>Regions with this specific type of soil: Oregon, Washington</p> <p>Species susceptible: <i>Gruner Veltliner</i></p>

2.5 Fossil Record

Unidentified fossilized seeds from India, donated to the Cleveland Museum of Natural History in 2005 and preserved among the museum's botany collections, were recently identified as the world's oldest-known *Vitis vinifera* species by the Florida Museum of Natural History

researcher. *Vitis* was thought to have originated during the Paleolithic era for a long time (66 million years ago), but there was no fossil proof, according to lead author Steven Manchester, curator of paleobotany at the Florida Museum. These fossils indicate that *Vitis*'s ancestors originated in India and then traveled to Eurasia, with the assistance of birds who carried the seeds in their stomachs through air. The new *Vitis vinifera* fossils were discovered in India's fossil beds in November 2013 as part of a new four-year research supported by the National Science Foundation. Researchers want to learn more about the species that once flourished there, as well as previous plant migratory routes between India and other continents. (*World's Oldest-Known Grape Fossils Found in India*, 2013)

Figure 3: World's Oldest Vitis vinifera Fossil (66 million years ago)



(World's Oldest *Vitis vinifera* Fossil, 66 Million years ago. Picture taken by Steven Manchester, 2013)

<https://www.floridamuseum.ufl.edu/science/worlds-oldest-known-grape-fossils-found-in-india/>

2.6 Soil Environment and Effects of Soil







It is commonly understood that soils have an impact on *Vitis* quality; in fact, the minerality effect refers to the impact of soil when paired with climate, topography, and grapevine type. It's important to separate soil attributes from dynamic or controllable soil qualities when considering the soil component of the terroir effect in regard to soil health. Other



studies have discovered impacts of soil nutrient availability, soil moisture, and soil temperature on *Vitis* quality, which are considered dynamic soil features. Concluding that dynamic soil features control soil health, and that a healthy soil is one that delivers soil functions to their full potential. Cool soils would be a benefit in hot areas since they might somewhat delay maturation, boosting particular tastes. Soil color has a significant impact on soil temperature; light colors have a strong reflection effect, which keeps the soil cold. The color of the soil is a natural feature. However, controls such as taking and leaving field crops waste on the surface can produce bright hues on the soil surface. While soil temperature appears to be related to region, it has not been factored to soil health evaluation. However, management measures that reduce soil temperature are strongly encouraged in terms of other soil health aspects. Nitrogen is one of most important elements for plant development, and it is by far the most often used fertilizer in cropping systems across the world. Since maintaining a strong Nitrogen supply is seen as a kind of crop insurance, it's no surprise that typical Nitrogen usage efficiency is as low as 50%. Nitrogen that is not carried up by the plant is frequently lost by washing or gaseous emission from the soil-plant system. While an appropriate supply of nitrogen is necessary for high agricultural yield, overuse of nitrogen fertilizer in recent decades has resulted in significant Nitrogen loss to the environment, posing a serious threat to air and water resources. (Lazcano et al., 2020)







2.7 Interaction of Plant Roots and Relationship With Animals







It has been proven that there are clinical findings where dogs get intoxicated with *Vitis vinifera*. Within 6–12 hours of ingestion of grapes or raisins, most dogs with raisin or grape toxicosis have vomiting and/or diarrhea. Fatigue, anorexia, stomach discomfort, weakness, dehydration, fluid retention, and tremors are some of the other symptoms. When compared to levels of serum nitrogen concentrations, serum creatinine levels grow earlier and more significantly. Within 24–72 hours of exposure, haemorrhagic or can cause kidney failure to develop; once anuric renal failure starts, most dogs die. In certain dogs, temporary elevations in blood glucose, liver enzymes, pancreatic enzymes, serum calcium, or serum phosphorus occur. (*Raisin and Grape Toxicosis in Dogs - Toxicology*, 2021.)



Table 2: Pests and diseases of *Vitis vinifera*

Type of Pest/Disease	Category	Description/ Symptoms	Image	Reference
Anthracnose (Bird's eye rot) <i>Elsinoe ampelina</i>	Fungal	On vines, there are dark red spots, deep gray lesions with a darker border, and lesions on the leaves that cause the leaves to curl. Root lesions can result in a ring of damage that kills portions of the plant; Tendrils, fruit stems, and leaf stems may also have lesions.	 	(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Armillaria root rot <i>Armillaria mellea</i>	Fungal	White fungal mats under the bark at the soil level; useless vines; quick wilt		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Botrytis bunch rot (Gray mold) <i>Botrytis cinerea</i>	Fungal	Disease thrives in humid environments with high temperatures.	 	(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Dieback (Eutypa dieback.) <i>Eutypa lata</i>	Fungal	Growth retardation, wilted leaves curled into a teacup form; darkish cankers on wood; crescent discolor in cross section. Affects vines that are five to six		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)

Type of Pest/Disease	Category	Description/ Symptoms	Image	Reference
<p>Esca (Black Measles or Spanish Measles) <i>Phaeomoniella aleophilum</i>, <i>Phaeomoniella chlamydospora</i></p>	Fungal	<p>years old.</p> <p>On leaves, branches, canes, and berries, the symptom occurs. We'll witness interventional patterning on leaves that resembles tiger stripes. Red crops have red patches and rotten strips, while white cultivars have wilt and rotting bands. On berries, we'll find superficial dots that may cluster later, turning the fruit black. When the trunk is cut there is a dark vascular streaking and dark liquid. This measles is sometimes associated with several secondary wood-rotting fungus that fully cover the vineyard.</p>		<p>(<i>Grape Diseases and Pests, Description, Uses, Propagation, 2014.</i>)</p>
<p>Leaf blight (Isariopsis Leaf Spot) <i>Pseudocercospora Vitis</i></p>	Fungal	<p>Researchers will detect oddly shaped lesions on the leaf surface. Lesions are first dull reddish to brown in color, becoming black later. These lesions may combine if the condition is severe. Researchers can detect symptoms on fruits that are comparable to black rot, but the whole group will collapse.</p>		<p>(<i>Grape Diseases and Pests, Description, Uses, Propagation, 2014.</i>)</p>

Type of Pest/Disease	Category	Description/Symptoms	Image	Reference
Leaf spot (Phomopsis cane) <i>Phomopsis viticola</i>	Fungal	Stems and leaves have black lesions with yellow margins; stems seem browned and may have dark staining; tiny deformed leaves; branch diseases cause cracking in the Vine.	 	(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Powdery mildew <i>Erysiphe necator</i>	Bacterial	White powdery development on leaves; white powdery growth on fruit; red spots on the stems. There are also yellow patches over the upper leaf surface.	  	(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Black rot <i>Guignardia bidwellii</i>	Fungal	Brown spots on the leaves that turn black, bright spots on grapes that turn black, the fruit hardens and turn black while still on the vine		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)

Type of Pest/Disease	Category	Description/ Symptoms	Image	Reference
				
Crown gall <i>Agrobacterium Vitis</i>	Bacterial	Gall on vines cause drooping and yellowing in <i>Vitis</i> . It also causes drying and collapsing on the fruit.	 	(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Pierce's disease <i>Xylella fastidiosa</i>	Bacterial	Yellow to reddish leaf edges and dry leaves with spiral bands of leaf death. Leaves fall but the stem remains connected to the vine. The fruit becomes dry and shriveled.		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Young vine decline <i>Phaeoacremonium spp.</i>	Fungi	The fruit starts to form yellow spots between the leaf veins which causes them to droop. It can also cause brown or purple lesions on the fruit which causes it to dry out and crack up.		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Black vine weevil <i>Otiorhynchus sulcatus</i>	Insect	It causes the vine to lose its vigor. It does damage specifically to the stems, flowers and leaves.		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)

Type of Pest/Disease	Category	Description/ Symptoms	Image	Reference
Grape mealybug <i>Pseudococcus maritimus</i>	Insect	This is considered a sporadic pest. It expulses sugary secretions onto the plant encouraging the growth of mold.		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)
Japanese beetle <i>Popillia japonica</i>	Insect	Leaves the plant skeletonized, causes flowers and buds to damage, the damage can be extensive. Its larvae develop in the soil.		(Grape Diseases and Pests, Description, Uses, Propagation, 2014.)

3.0 Chapter 2: Biology

3.1 Sexuality and reproduction

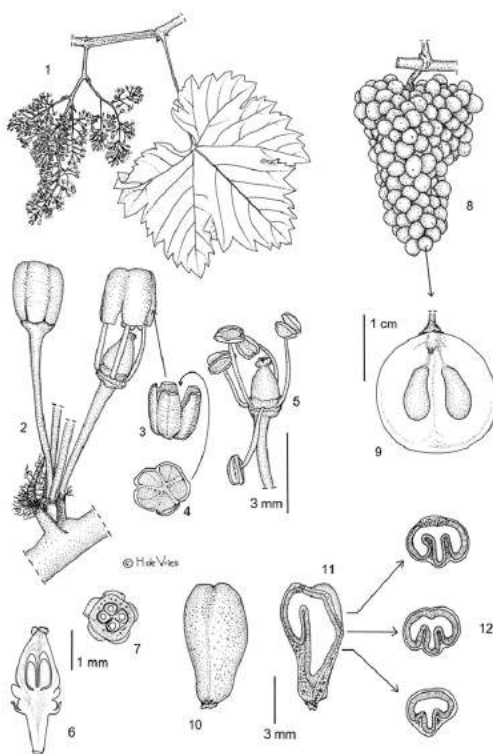
It's all about the flowers when it comes to making crosses. *Vitis*, like many other creatures, reproduce through sexual reproduction. To put it another way, each seedling is a unique mix of genes from a female and a man. Pollen from a male fertilizes the female ovary, resulting in the formation of a seed. Flowers can be female, male, or hermaphroditic, depending on the vine (also known as "perfect", which means that each flower contains both male and female structures). Genderless variants make up the bulk of cultivated cultivars. Because fruit cannot be produced without fertilization, hermaphroditic vines are favored because they can fertilize themselves, and every vine planted has the potential to yield fruit. The stamens are the male portions of the flower, consisting of a pollen-bearing anther supported by a filament. Anthers are usually placed in fives around the ovary, but certain types may have more or less. Pollen is discharged when the anther ripens and is carried mostly by the wind, however it is seldom carried more than 20 feet (7 meters) from the source. Pollen settles on the female portions of a flower, causing pollination. Each pollen grain develops a lengthy tube that leads to the ovary's eggs, and sperm cells go down this tube. The ovary, stigma, and style make up the feminine portions of the flower. The stigma and style serve as pollen entrances to the ovary. An embryo (a new seedling plant) is formed when a sperm cell in the pollen tube combines with an egg cell in the ovary. The embryo develops within the growing seed, while the entire ovary develops into the grape berry, complete with seeds. (*Breeding Grapes - Grape Flowers*, 2017.) *Vitis vinifera*'s flowers contain a joined petal structure called a "calyptra," which opens from the bottom of each individual petal, in addition to pollen. The majority of grape varieties are self-pollinating and hermaphroditic (they have both male and female reproductive systems). As the calyptra disconnects from the flower base, anthesis happens. Pollen grains create tubes that extend through the stigma's tissues and into the ovule causing the fertilizing on the egg under ideal conditions. The fertilized egg becomes an embryo shell, which grows into a seed. (*NMSU: Grapevine Phenology: Annual Growth and Development*, 2020.)

3.2 Chromosome Complement

In the *Vitis vinifera* species, two chromosomal numbers have been reported: $n=19$ and $n=20$. The majority of writers believe that 19 is the right number, and that claims of a greater chromosomal number in other types are false, because the chromosomes are so tiny and impossible to measure. According to a survey of the literature, *Vitis vinifera* has two chromosomal numbers: $n=19$ and $n=20$. The number of homologous chromosomes observed in 86 cultivated cultivars is $2n = 38$. Except for one triploid seedling, all 129 seedlings developed from self-pollinated seed of numerous diploid kinds had the standard number 38. The number of chromosomes in *Vitis vinifera* is $n=19$, $2n=38$. (Olmo, 1937)

3.3 Pollen and Flower Production

Figure 5: *Vitis vinifera* Flower Chain

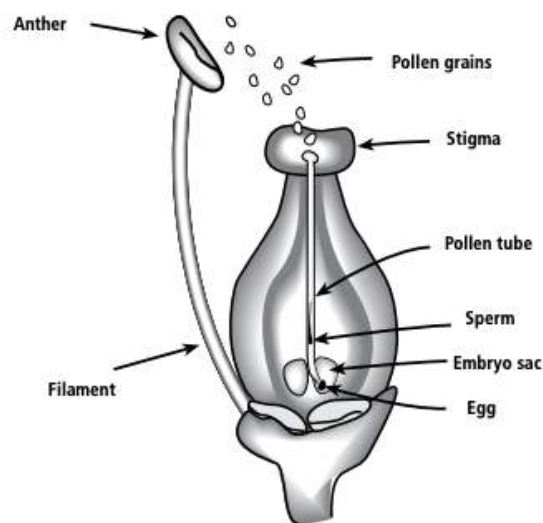


(*Vitis vinifera* L., Weebly- Flower Chain)

<https://www.flowersofchania.com/vitis-vinifera-l.html>

Pollen is released more effectively in dry weather since rain and high winds reduce pollen density. A pollen grain that lands on the stigma's sensitive tissue may germinate and generate a pollen tube. Pollen germination is best when the temperature is between 26 and 32 degrees Celsius in *Vitis vinifera*. The fruit blossoms in a unique way compared to other flowers. *Vitis Vinifera* petals are green, and instead of flowering, they separate from the flower at the bottom, forming a cap. Unopened buds are sometimes mistaken for little green grapes due to their look. Male and female blossoms on each vine. The pollen-bearing organs, anthers, are completely formed in male flowers, but there is little or no ovary/pistil. Female flowers feature a big, well-developed ovary and pistil, and while the anthers are nearly as large as male anthers, they are reflexed (curl down and under) under the flower, and any pollen they generate is sterile. Wind and insects, such as tiny flies, pollinate the flowers. (*Grape Breeding 101*, 2016.) They will frequently benefit from the presence of a pollinator. Brighton, a widespread *Vitis* variety that is not self-pollinating, is an exception. Brighton needs the pollination of another grape in order to bear fruit. (*Pollinating Grapes*, 2018.) Pollination and fertilization may not be the same thing, but they are both two main processes. After pollination begins, the entire process takes 2–3 days to complete. A single flower group can have up to 1,000 blooms, and a fruit set is successful if one out of every three blossoms, or 33 percent, matures into a grape berry. During the early phases of berry growth, the remaining blooms wilt, and die. This time is known as "shatter," and it can last anywhere from 10 to 14 days. Separated flower petals that would not fall off the clusters could provide fungus with food. (*NMSU: Grapevine Phenology: Annual Growth and Development*, 2020.)

Figure 6: Pollination and fertilization process



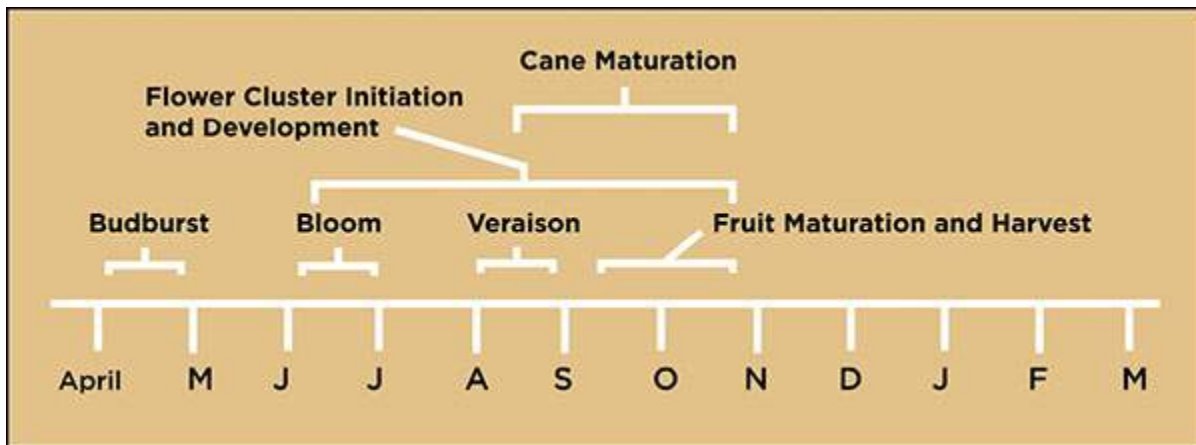
(Dokoozlian, 2016)

<https://iv.ucdavis.edu/files/24467.pdf>

3.4 Life Cycles and Phenology

Phenology is a method used by grape producers to monitor, recognize, comprehend, and explain the grapevine's yearly growth and development stages. The E-L system is an effective method of describing grapevine phenological phases. This information is used to make decisions on vineyard site selection, cultivar and rootstock selection, spraying, fertilization, vineyard floor, and canopy management, as well as harvest. There are two main developmental cycles in *Vitis Vinifera* phenology: vegetative and reproductive. One growing season is required to complete the vegetative cycle. The reproductive cycle takes two seasons, with flower inflorescences forming in the first year and flower beginning, blooming, and fruiting in the second (*NMSU: Grapevine Phenology: Annual Growth and Development, 2020.*).

Figure 7: Annual cycle of *Vitis vinifera* growth



Annual cycle of grapevine growth (figure by Hellman, 2003).

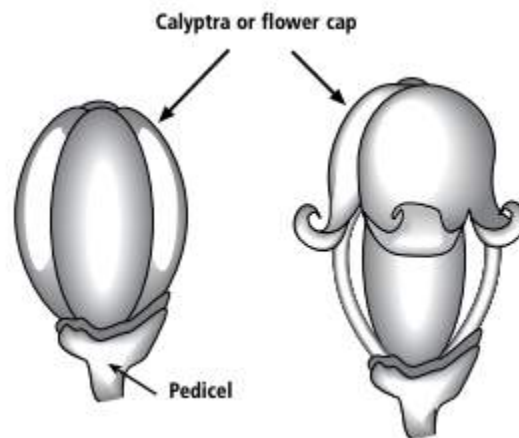
https://aces.nmsu.edu/pubs/_h/H338/welcome.html

The yearly growth cycles of vines is the yearly process that begins with a bloom break in the spring and ends with leaf fall in the fall and by winter hibernation in the vineyard.

3.5 Anthesis

Before *Vitis vinifera* flower opens in the spring, the calyptra (flower cap), which is made up of five joined petals which covers and protects the flower organs. When the calyptra disconnects from the flower core and is torn, the filaments and pistil are exposed. This is known as flower opening or bloom. Depending on the climatic condition, anthesis usually happen 6 to 8 weeks following the start of stem development. When temperatures are between 85° and 95°F (29° & 35°C), anthesis occur quickly, for example, 'Thompson Seedless' vineyard reaching full bloom 6 to 7 days following the onset of flower opening. Under chilly conditions, anthesis can extend up to two weeks, and very few flowers may open if the temperature is below 65°F (18.3°C). (Dokoozlian, 2016)

Figure 8: A grape flower shedding its calyptra (flower cap) during anthesis



(Dokoozlian, 2016)

<https://iv.ucdavis.edu/files/24467.pdf>

3.6 Fruit development and seed set

Grape berry growth may be divided into three phases. Berries grow by cell division during stage I, which begins during the fruit set. The Lag Phase, or Stage II, begins with a stop in berry development while seed embryos begin to form and mature. Cell division ceases, and cell expansion is the only way to continue growing. When berries change their color, soften, build sugars, and metabolize acids, it leads to Stage III. Until veraison (change of color), berries are the vine's method for distributing ripe seeds via bird or other vertebrate ingestion. Acids and tannins that build up before to change of color guarantee that they remain bitter. Changes in color, softening, sugar buildup, and acid decrease occur during veraison , increasing the appeal

and palatability of grape seeds to birds and other animals that ingest and distribute them. (*Stages of Grape Berry Development – Grapes, 2022*)

Table 3: Grape Growth Stages

Stage I: Berry Formation	The development of berries is the first step. This phase begins at blooming and lasts for around 60 days. The berry is created during this phase, and fast cell division occurs. The fruit grows in size and collects substances like tartaric and malic acid, but not much sugar. Tartaric acid is also very important because it accumulates the most in the skin. It is a key component because it develops during the early stages of fruit growth. (<i>Stages of Grape Berry Development – Grapes, 2022</i>)
Stage II: Lag Phase	The lag phase is considered a pause in <i>Vitis</i> growth in which seed embryos start to grow very fast. At the beginning of the lag phase, the fruits have reached about half of their terminal size. During 5-10 days, cells expand and continue to absorb acids which helps them change their color and size. (<i>Stages of Grape Berry Development – Grapes, 2022</i>)
Stage III: Post-Veraison Berry Ripening	Veraison is the third step, which involves the berry softening and coloring, the increase of soluble sugars, as well as the reduction of acids. The fruit doubles in size during this period. Although this is significantly connected with climate, the amount of acid in the soil must have decreased. Malic acid levels are usually lower in warm-climate grapes, whereas higher amounts are seen in cooler-climate grapes. Seed toxins decay during the second development phase due to oxidation, when they get bonded to the seeds. (<i>Stages of Grape Berry Development – Grapes, 2022</i>)

3.7 Foliage and Growth

Vitis vinifera is commonly assumed to be suited to the “chilly” environment, yet there's several kinds that grow in the country's warmer regions. They may be cultivated successfully in greenhouses and sweet grapes do better under cover since they require a lot of heat to properly mature. Each year, the grapevine's yearly development cycle involves several processes and

interactions in the vineyard. The following stages of grapevine development are typically used to characterize annual growth:

1. Budburst
2. Flower cluster initiation
3. Blooming
4. Fruit set
5. Berry development
6. Harvest
7. Budburst







The start of a new phase in the vineyard lifecycle is signaled by the succession of each event. Due to the grape type, local environment, and seasonal weather, the time and intensity of events might vary, however the sequence of events stays consistent. Many of these events are acknowledged to overlap for a period of time, necessitating the vine to distribute its resources to various activities (*Grape Grower's Handbook: A Guide To Viticulture for Wine Production, 2022*).

3.8 Seedling Protection

Inside the vine there are specialized cells arranged into a vascular system that transports water and dissolved substances throughout the vine. The vascular system is divided into two components: xylem is the conducting system that transfers water and dissolved nutrients from the roots to the rest of the vine, and phloem is the food-conducting system that transports photosynthetic products from leaves to other parts of the vine. Each of the xylem and phloem tissues is made up of multiple distinct types of cells, some of which provide a constant channel throughout the plant and others which give support services to conducting cells, such as food storage in xylem cells (Hellman, 2003).

Figure 9: Grape vine Growth Stages- Vegetative growth

Grapevine growth stages




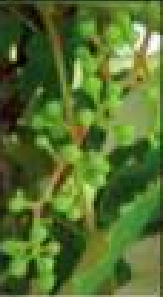



Vegetative growth						
Dormant	Early bud swell	Late bud swell	Bud burst	1- to 3-inch shoots	4- to 8-inch shoots	10- to 16-inch shoots
						
Bud closed. No visible indication of growth.	The bud is visibly swollen, brown and fuzzy. No green or pink tissue is visible yet.	The bud has elongated and green or pink leaf tissue is visible though bud is still closed.	The leaves have separated at the tip, usually exposing the growing point.	The shoot is 1-3 inches (2.5-7.5 cm) long with 1-3 small leaves at right angles to the stem.	Shoots are 4-8 inches (10-20 cm) long with 3-6 leaves. Flower clusters are exposed.	Shoots are 10-16 inches (25-40 cm long). Flower clusters are clearly visible.

Grapevine Growth Stages (Michigan State University, 2022)

<https://www.canr.msu.edu/grapes/uploads/files/Growthstages.pdf>

Figure 10: Grapevine Growth Stages- Reproductive growth

Grapevine growth stages

Reproductive growth						
Immediate prebloom	First bloom	Full bloom	Buckshot berries	Berry touch/ bunch closure	Veraison	Ripe for harvest
						
Caps are still attached. No flowers are visible.	First flowers open, caps are falling off.	Most of the flowers are open.	Berries are the size of buckshot pellets.	Berries touch and cluster is starting to close.	Berries soften and change color as they begin to ripen.	Berries are soft and ripe with high sugar content.

Grapevine Growth Stages (Michigan State University, 2022)

<https://www.canr.msu.edu/grapes/uploads/files/Growthstages.pdf>

3.9 Productivity and Biology

Grape vines are annual plant vines. They frequently grow near rivers and other typically open settings. They frequently hang and contain branches in open forests and forest borders. Grape leaves frequently have three basic parts. The leaves are arranged in a zigzag pattern along the stem. Vines, which develop in a spiral pattern opposite most leaves and anchor the vine to its supporting structure, are vital in attaching the plant to its supporting structure. Small, insignificant blooms are grouped in bunches on grapes. The nectaries on the flowers are vital for attracting the insects that fertilize grapes. The fruit is a purple, two-seeded, edible berry with two seeds. Birds and animals consume grapes in large quantities. Grape cultivars are grown by grafting desired type branches onto the root of a very resilient plant. The ideal characteristics of the species will be presented by the planted stem, and the grape farmer will be able to benefit from the rootstock's adoption towards the local environment (*Grapes | Encyclopedia.Com*,

2019). Small, inconspicuous flowers are grouped in bunches on grapes. The flowers have nectaries that are vital in attracting the pollinators of grapes, which are insects. Grapes produce an edible, two-seeded berry that is generally purple in color. Birds and animals *Vitis*. The grape seed travels through these animals' guts unharmed and is released in the ground with their feces. Grapes' edible fruit is an adjustment for animal virus transmission (*Grapes - Biology Of Grapes*, 2022).

3.10 Ecophysiology

The termite's excavation and nest-building activities are thought to have formed distinct landscape characteristics in *Vitis vinifera*. They have recently been studied in the Western Cape's wild bootm and are the focus of numerous ecological studies, but their impact on cultivated landscapes has remained unclear. This research focuses on the vigor and physiology of on- or off grapes. To better understand how differences in *Vitis vinifera* characteristics correspond to differences in rainfall and temperature (Bekker et al., 2016).

3.11 Class ovule development

A complete knowledge of the genetic processes behind the blooming process is critical since it has a significant impact on winemaking and grapevine productivity. In addition, the development of the ensuing population of berries is dependent on each step of flower production. When it comes to the reproductive system of *Vitis vinifera*, as well as some American and Asian varieties, are self pollinating, having male and female flowers, but all of the major grape and wine varieties have hermaphroditic flowers in their inflorescences. Each flower is identified from the exterior by four aspects: flowers, stems, pollen, and petals. The calyx, which is made up of five sepals, is the exterior ring, while the calyptra, is a transformed epidermal membrane made up of five connected petals. Despite the fact that both structures cover the inner reproductive spindles, the calyx is a constant coating, and the calyptra is discharged when the pollination has matured. The conservation and preservation is made up of five flowers, each of which is made up of long filaments (Palumbo et al., 2019).

4.0 Chapter 4: Propagation and Management

4.1 Natural regeneration

Vitis Vinifera grows best in areas that have an average temperature of 10°C and 15°C. *Vitis* needs strong light and a humid but not too warm weather for it to grow successfully. If there is a combination of silicone and low and humid weather it will generate a better result and help the plant survive more than 360 days (Moriguchi et al., 1988).

4.2 Nursery Propagation

Vitis vinifera produce just one harvest of fruit every growing season but have a short life expectancy. While there are few of these *Vitis*, the majority of *Vitis* are between the ages of 10 and 30 years. When vineyard owners want to replant existing vines, they can use a variety of techniques, such as planting a fresh cut that has been chosen using genetic or group selection. Vines may also be reproduced by transplanting a new plant grapevine onto an existing root or placing one of an existing vine into the soil beside the vine and cutting the attachment after the new vine grows its roots. Because each seed has different genetic data from its two parent types, the floral parent and the parent that gave the pollination that fertilized the flower (“Propagation of Grapevines,” 2022).

4.3 Planting

For *Vitis vinifera* to grow it needs full sun around seven to eight hours every day. No sun can cause a lower fruit output, decreased fruit quality, increased fungal growth, and fruit rot. Grapevines can grow and yield in a variety of soils, but proper drainage is essential. Roots may grow up to 15 feet deep. Grapevines can grow and yield in a variety of soil types, but proper drainage is essential. Even though most of the roots develop in the first three feet of soil, they can grow up to 15 feet deep. As a result, soils must be at least three to four feet deep above soil surface, stacked layer, or rock, however this should be done with care (*Stages of Grape Berry Development – Grapes*, 2022).

4.4 Propagation from seed

Because grapevine seeds do not generate plants that look like mother plants, they are normally only seeded by plant breeders looking for new grape types. You may do the same thing, however your seedling may not be as good as the mother plant. Some seedlings can yield fruit in as little as two years, while others might take up to seven years to grow (*How to Grow Grapes from Seed*, 2011). There are various steps for growing grapes from a seed, they are the following:

1. Acquire Seeds

By chopping fully ripe grapes horizontally, you may harvest the seeds. Remove the seeds taking care not to damage the seeds. Allow the seeds to soak for 24 hours after putting them to soak in water, avoiding and removing any that do not sink (Stallsmith, 2011).

2. Prepare Seeds

After 24 hours, drain the leftover seeds and set aside with some moist potting soil. For approximately 50 seeds, one scoop of potting soil should be enough. The seeds should be refrigerated for three months after covering it at 35 to 40 degrees Fahrenheit. The layering period refers to the time spent exposed to cold (Stallsmith, 2011).

3. Sow Seeds

After a while let the seeds be at room temperature and set flat in a wet and sterile seed-starting mix to let them germinate. The flat surface should have drainage at the bottom so not lots of moisture is accumulated. When planting the seeds you should plant them 1 ½ inches apart. They should be under direct sunlight for about 16 hours and the seed-starting mix should be mixed constantly. Some seeds germinate within two weeks if the temperature maintains at 70 degrees fahrenheit, but it may take two months or longer for the seeds to germinate (Stallsmith, 2011).

4. Hasten Germination

According to reports, soaking grape seeds in flowing water removes their germination regulators, removing the need for a conditioning period. The seeds can begin to form roots in eight days under these conditions, following which they'll be planted as stratified seeds with no roots. If kept in water for more than 12 days, their roots will start to brown (Stallsmith, 2011).

5. Nourish Seedlings

The seeds must be transplanted into their own 4-inch-diameter pot. The pot should be filled with a combination of 8parts potting soil, 1 part pumice and one part sand. Fertilizer should be added so there is a better growing condition and result. When each plant has gained six leaves to its initial two seed leaves, the young *Vitis* should be ready to go outside. Set the vines' pots in a shaded spot for a few hours every day at first to acclimate them to outside conditions, then bring them back inside for the remainder of the day. They should gradually be placed to light (Stallsmith, 2011).

6. Plant seedlings

The pot should be selected for the grapevines after the latest normal spring frost date in the area, assuring full sun exposure and fairly rich, well-drained soil. *Vitis* seedlings should be planted 8 to 10 feet apart, with each planting hole larger and deeper than the root ball of its particular vine, and the vines at the same soil depth as they grew in their pots. By filling the remaining holes with the dirt you removed to form the holes, making sure the soil all around plants is even with the ground. Remove the lowest two leaf blooms from each grapevine. During the first year, make sure the plants' soil is adequately watered and that they receive at least 1 inch of water every week (Stallsmith, 2011).

4.5 Management

Diseases limit the success of the plant development. There are different types of diseases such as fungi, bacteria, and viruses. To prevent this there should be considered several requirements (Smith, 2019).

1. Site selection. There should be a good site selection that not only is virus free, but has good soil and climate conditions.
2. Cultivar selection. Choosing cultivars can reduce fungicide making the plant more resistant to any type of disease.
3. Acquire a Nursery stock that is free of pathogens.
4. Consider training systems to ensure air circulation.
5. Sanitation is crucial to prevent the chance of diseases.

4.6 Vegetative propagation

Cuttings must be 12 to 18 inches in length and have four buds on them. Three of the blooms should be buried, while the fourth should be kept above ground. Root production can be accelerated by soaking the tip of each cut in rooting hormone. As soon as the cuttings are pruned, they should be planted in the soil (Gerard, 2021).

4.7 Tending

Each spring, fertilize the grapevines with a 10-10-10 fertilizer 30 days before the growth season begins. In the second year of development, apply 1 pound of fertilizer per vine, increasing to 1 1/2 pounds within the third year, maintaining the fertilizer 6 to 12 inches apart from the vine's trunk (Gerard, 2021).

4.8 Fruiting

Vitis vinifera, like any other plant, needs nitrogen. This is especially during the spring which can cause ideal rapid growth. Vines should be fed specially during the months of January or February (Grant, 2022). The soil Ph is crucial for a successful fruiting process for the plant, the ph has to be in between 5.5 and 7.0 levels of Ph. If there is a lack of magnesium, phosphorus or potassium then the vine won't be able to grow effectively. Zinc and ammonium nitrate are beneficial for the vines' growth and strength.

4.9 Vegetation Components

Vitis vinifera is a plant that grows tall and thick in the wild. In order to regulate the quantity and type of the grapes, the vineyard's growth is maintained by clipping it. *Vitis*, like any other plant, has underground and above-ground parts. An subterranean trunk with a root system makes up the underground portion. The stem, canes, and branches make up the above-ground portion. There must be leaves, tendrils, blossoms, and grapes on the one-year-old branches (Urška, 2017). *Vitis vinifera* may be separated into three parts: the outer skin, pulp, and seeds, which are all visible to the naked eye. The grape fruit, on the other hand, is divided into separate morphological and anatomical divisions (Hanumangirl, 2016).

Figure 11: Grapevine Structure

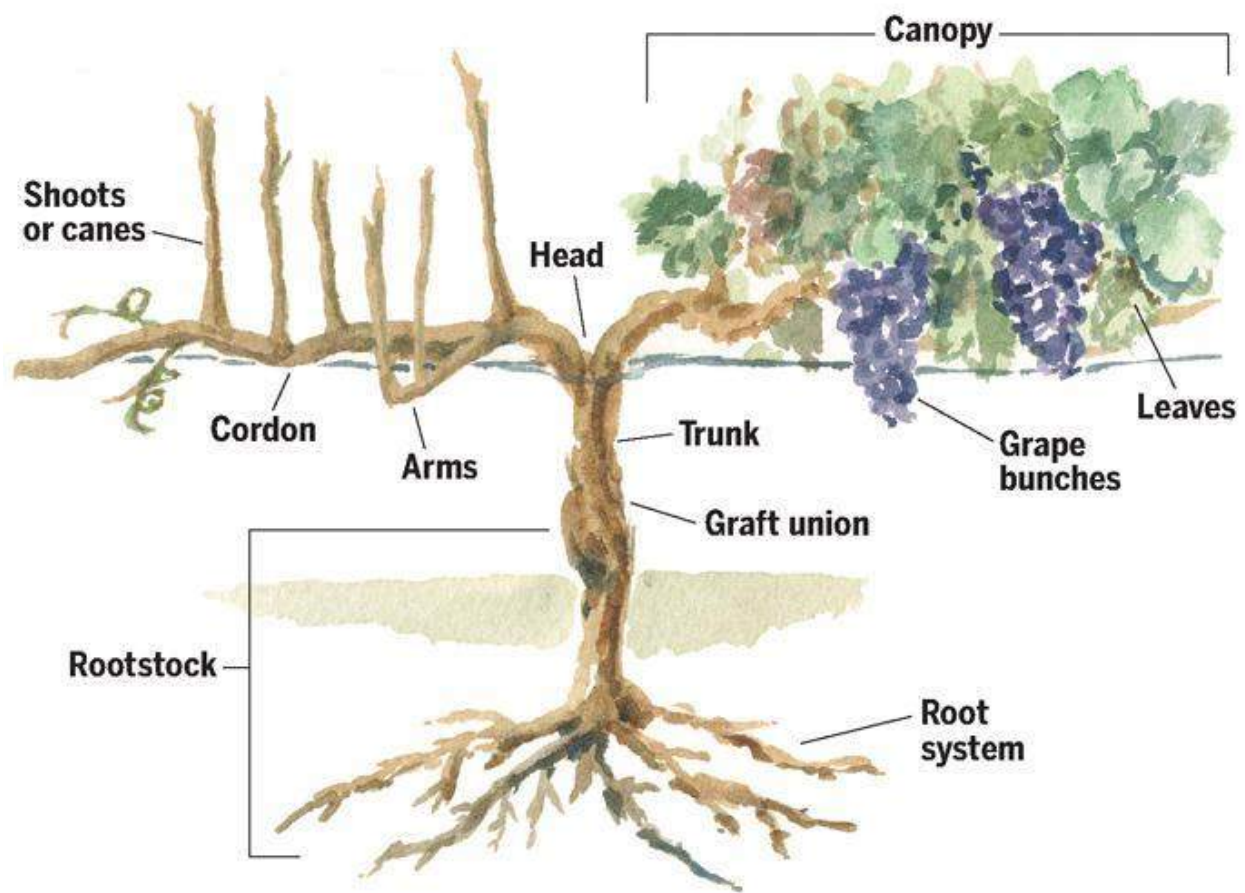
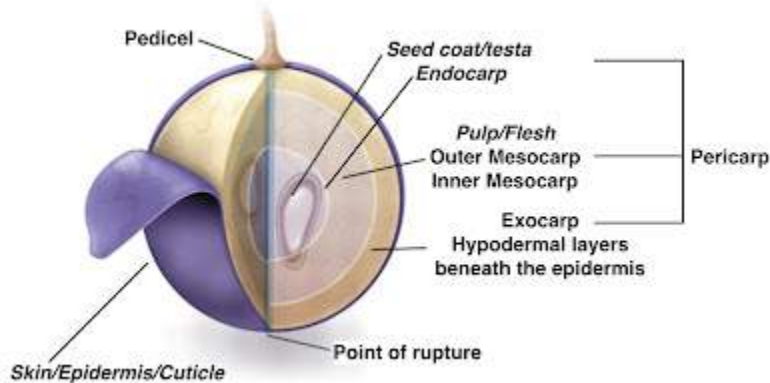


Photo (Dave Johnson for Bay Area News Group): Grapevine Structure

<https://www.evineyardapp.com/blog/2017/05/30/overview-of-grapevine-structure-and-functi>

Figure 12: *Vitis vinifera* Inside Structure



(Hanumangirl, 2016): Grape structure

<https://enoviti-hanumangirl.blogspot.com/2016/12/parts-of-grape-berry.html>

4.10 Harvest

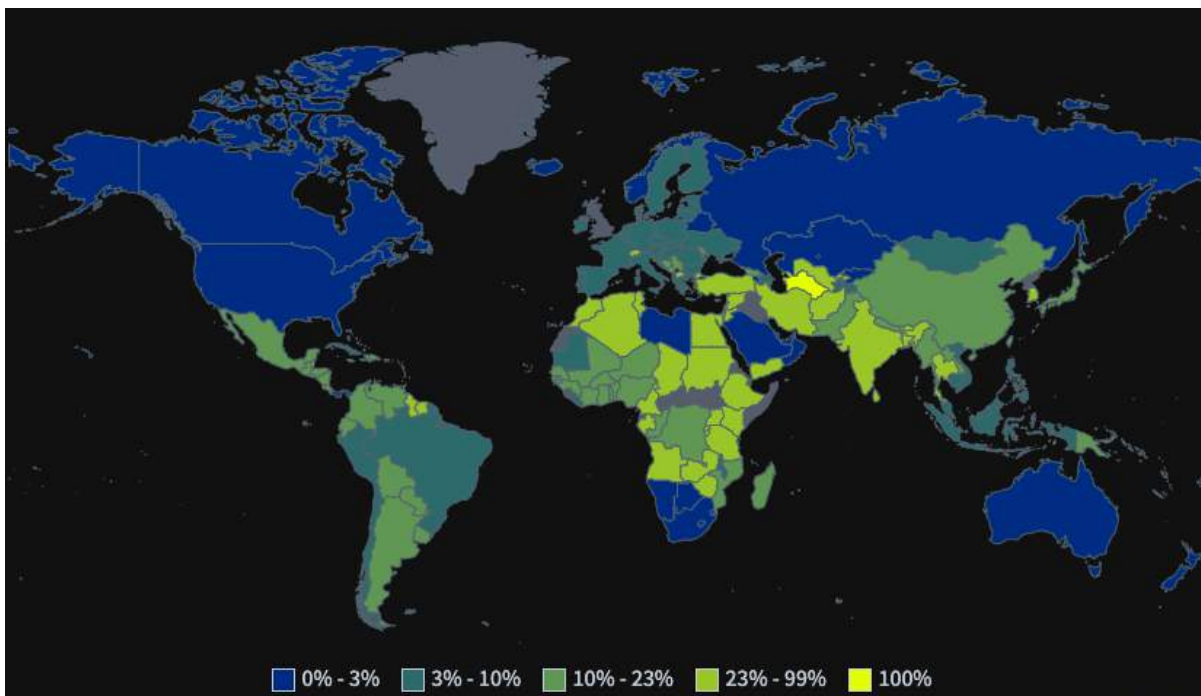
Harvesting of *Vitis vinifera* occurs around the turn of the season, which in the northern hemisphere can range from the end of August to the middle of October. In the southern hemisphere, harvests typically take place from late February through April. Late harvest and ice wine grapes require longer hanging durations (on the vines), thus they are often picked a few months later. Sampling the fruit from different sections of the vineyards (when done by professionals) may reveal a lot, especially when *Vitis* ripen at different times. A simple gadget known as a refractometer, which measures the amount of sugar in *Vitis*, known as the 'brix' level, may be used to validate real sugar levels. This, as well as acidity and phenolics, is increasingly being tested in laboratories (*When, Why and How Does the Wine Grape Harvest Happen?* | *Clos19 Germany*, 2021.). Harvest of *Vitis vinifera* can be both had picked or picked out with a machine.

Chapter 5: Grape Value Chain and Uses

5.1 Imports and Exports

Grapes, fresh, were the 316th largest traded product in the world in 2020, with a total trade value of \$9.31 billion. Grapes, fresh exports increased by 5.67 percent between 2019 and 2020, from \$8.81 billion to \$9.31 billion. Fresh grape commerce accounts for 0.056% of total global trade. In the year of 2020 there were five top exporters, Chile with \$1,06B, China with \$1,04B, Peru with \$1.01B, Italy with \$828M and the United States with \$784M. In addition to exporters, importers were also crucial to the grape's economic value. The top importers were: the United States with \$1.33B, Germany with \$784M, China with \$779M, Netherlands with \$715M, and the United Kingdom with \$604M (OEC, n.d.).

Figure 13: World Tariffs for Grapes



OEC. (n.d.). *Grapes, fresh (HS: 080610) Product Trade, Exporters and Importers* | OEC.

OEC - The Observatory of Economic Complexity. Retrieved April 21, 2022, from

<https://oec.world/en/profile/hs92/grapes-fresh>

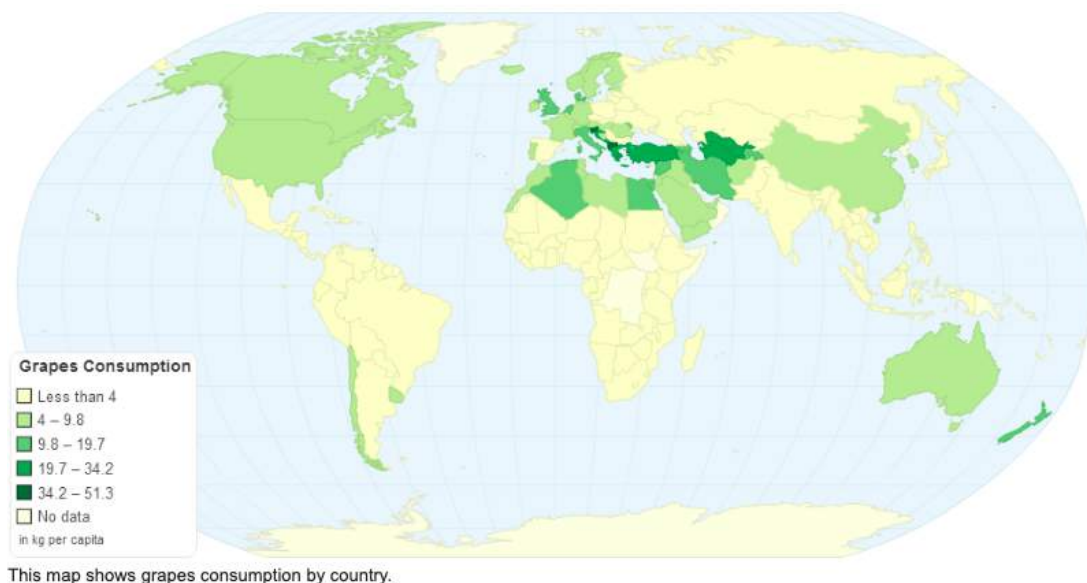
5.2 Packing and Transporting

When grapes are packaged they often come in fruit crates, each containing 10kg of vitis in them. There are stems with the fruits that will be packaged individually with an exceptional quality. They are placed in wool-lined cartons or perforated polyethylene film in fruit crates. These packages should be anti-mold to prevent vitinis from rotting. It is also important to add how while being transported the grapes should be refrigerated and protected from moisture which can cause a risk of spoilage. *Vitis vinifera* is usually transported on aircraft, ship, truck and railroad to facilitate its transportation and quickly delivered and consumed (TIS, 2022).

5.3 Consumption

China continues to be one of the world's largest grape consumers, accounting for 19 percent of overall consumption with 14M tonnes. Furthermore, grape consumption doubled that of the country's second consumer, the United States with 6.9 million tonnes. Italy took third place in this ranking with 6.7 million tonnes, accounting for 8.9% of the total. Between 2007 and 2018, grape consumption in China climbed at an annualized rate of +7.1% on average. The remaining consuming nations' estimated yearly rates of consumption were as follows: the United States with +0.4 percent per year and Italy with +0.4 percent per year. *Vitis* can be consumed in different ways such as raw, dehydrated, juiced (wine), etc (Research and Markets, 2019).

Figure 14: Grape Consumption worldwide



ChartsBin. (2022). *Grapes Production and Consumption by country*. ChartsBin.

<http://chartsbin.com/view/32887>

5.4 Benefits and Uses

Vitis vinifera has many types of uses and benefits. Grapes are beneficial for the human body, especially with the immune system, preventing cancer, lowering blood pressure, protecting against heart disease, reducing high levels of cholesterol, protection against diabetes, assures better brain health and improves bone health (Healthessentials, 2021).

5.5 Wine

Wine is the most common grape based product worldwide. It is an alcoholic beverage made out of fermented grape juice. The production of grapes, particularly for the production of wine. Growing grape vines as an agricultural activity. Wine has a whole process of fermentation. First, grapes have to be harvested. *Vitis vinifera* for wine are similar but not the exact same from consumption. The thicker peel of wine grapes provides additional taste to the wine. Because these grapes are smaller than table grapes, they have a more concentrated flavor. A vine has less wine grapes on it, in addition toward being smaller (Whilhem, 2020). After the wine grapes are harvested their juices need to be extracted, in this case by crushing them. The destemmer machine, which effectively eliminates the stems and parts you don't want smashing the grapes into liquid mush, is now commonly utilized for the majority of wines. The skins and seeds of white wine are removed to eliminate any color that can contaminate the liquid, but the skins of red wines are left on. After the crushing process is done, fermentation is the next step. With a variety of processes to complement the various types of grapes, the sugar in the combination changes to alcohol. The most natural method is to just add yeast and wait for it to ferment. CO₂ is released in red wines, which are fermented at higher temperatures than white wines. The process of making red wine normally continues until all of the sugar has been converted to alcohol, resulting in a dry wine. White wines could also be fermented to dryness, but sweet wine variations are stopped before all of the sugar is transformed, resulting in a smoother and less alcoholic beverage. There's even a chance that grapes may be crushed after fermentation to add richness and smoothness. After fermenting the grapes they have to be aged. This process depends on the time, place and process. Wines can be matured in stainless steel or oak barrels for a few months to many years, and can be new oak, neutral, American, or French barrels. There are even different levels of being 'toasted,' which refers to the barrel being burned by fire.




A wine's flavor can get stronger over time. The wine should then go through a filtration process which would remove the texas particles for a smoother result. The wine is then bottled and distributed around the globe (Sightseeing, 2022).

5.6 Wine distribution

Right now there are five countries that produce wine as one of their main products, these are: Italy, Spain, France, the United States and China. Still the largest wine supplier in the United States is Southern Glazer's Wine & Spirits. According to Wines Vines Analytics, it services 36 states and 1,178 wineries. Forbes magazine projected the company's sales in 2016 to be \$16.5 billion (Gordon, 2017).


5.7 Types of wine

Table 3: *Types of wine's*

Type of wine	Type of grape	Summary	Image	References
Red wine	Cabernet Sauvignon, Merlot, Pinot Noir, Zinfandel, Syrah, Malbec, Tempranillo, Sangiovese, Barbera, Carmenère	Allowing the grape skins to soak in the extracted juice gives red wine its color and taste. Red wine is prepared from grapes that are dark in color. The color of a wine can vary from violet, which is typical of youthful wines, to red, which is typical of mature wines, and brown, which is typical of older red wines. Most red grape juice is definitely greenish-white; the red color comes from anthocyanins found in the grape's skin. The teinturier family of uncommon teinturier cultivars, which have crimson flesh and generate red juice, is a striking exception.	 	<p>(<i>The World's Favorite Wine Grapes</i>, 2022)</p> <p>(Inc, 2022)</p>
White wine	Chardonnay, Sauvignon Blanc, Pinot Gris, Semillon,	Grapes are pressed swiftly and the liquid is promptly wiped away from the grape skins to create white wine. Red grapes can be utilized		(BEVERAGE TRADE NETWORK, 2021)

Type of wine	Type of grape	Summary	Image	References
	<p><i>Viognier, Gewurztraminer, Viognier, Chenin Blanc, Gruner Veltliner, Torrontes, Muller-Thurgau, Silvaner, Pinot Blanc, Muscat, Airen, Roussanne, Garganega, Verdicchio, Marsanne, Albarino</i></p>	<p>if a winemaker is cautious to not let the skin color the brew during the pulp-juice separation. Pinot noir (a red grape) is a typical ingredient in champagne.</p>		<p>(<i>The World's Favorite Wine Grapes</i>, 2022) (Evans, 2022)</p>
Rosé	<p><i>Grenache, Sangiovese, Syrah, Mourvèdre, Carignan, Cinsault, and Pinot Noir</i></p>	<p>Red grape skins provide color to rosé wine, but still not enough to make it a red wine. It's possible that it's the earliest known sort of wine, as it's the easiest to manufacture using skin contact method. Based on the varieties being used in wine making procedures, the hue can range from light orange to a vibrant near-purple. Contact, saignée (removing juice from the must early in fermentation and continuing fermentation of the juice separately), and combining a red and white wine are the three main methods for making rosé wine (uncommon and discouraged in most wine growing regions). Its sweetness level can vary.</p>		<p>(<i>The World's Favorite Wine Grapes</i>, 2022) (BEVERAGE TRADE NETWORK, 2021)</p>

Type of wine	Type of grape	Summary	Image	References
<i>Orange (ambar)</i>	<i>Pinot Grigio, Ribolla gialla, Georgian Rkatsiteli</i>	These wines are sometimes referred to as amber wines since they are manufactured with white grapes however the skins are left to soak during the pressing process, similar to red & rosé wine making. They're tannic, and they're normally served dry.		<p>(<i>The World's Favorite Wine Grapes</i>, 2022)</p> <p>(BEVERAGE TRADE NETWORK, 2021)</p>
<i>Sparkling</i>	<i>Chardonnay, Pinot Noir, and Pinot Meunier</i>	Sparkling wines must go through a second fermentation process to produce carbon dioxide, which is what causes the bubbles. The traditional method, which is used for Cava, Champagne, and more costly sparkling wines, as well as the Charmat method, which is used for Prosecco, Asti, and much less expensive wines, are two typical ways to do this. A mixed transfer method also is utilized, which yields intermediate results, and in the cheapest wines, simple carbon dioxide addition is used. The gas pressure behind the cork, which may be up to six standard atmospheres, requires robust bottles for sparkling wine.		<p>(<i>The World's Favorite Wine Grapes</i>, 2022)</p> <p>(BEVERAGE TRADE NETWORK, 2021)</p>
<i>Dessert</i>	<i>Sémillion, Sauvignon Blanc, Riesling and Chenin Blanc</i>	This is a term used to describe sweet wines which have a lot of sugar left over after fermentation. Enhancing the quantity of sugar in a wine may be done in a variety of		<p>(<i>The World's Favorite Wine Grapes</i>, 2022)</p> <p>(BEVERAGE TRADE NETWORK,</p>

Type of wine	Type of grape	Summary	Image	References
		methods, resulting in wines of varying intensities and names.		2021)

5.8 Wine in Colombia

Colombia, a country located in the tropics, has all types of climates; from deserts to high mountains that can even have snow on their peaks. *Vitis* is mainly grown and produced at 2,600 meters over the ocean which has an average temperature of 14°C. Despite arriving with European invasion at the beginning of the 16th century, its cultivation expanded late, long into the 20th century. Colombia was an importer till the first decades of the 20th century, due to its adverse environment and problems in sustaining stable vineyards. The vineyards which are active at this moment are mainly located in the state of *Boyacá*. Wine production is not very strong but is still growing. New types of technology are being developed and implemented to assure the success of this crop. As the *Vitis vinifera* market grows, it can be used as a monetary source which can be very favorable for the country (Cata, 2016).

References

- Britannica, T. Editors of Encyclopedia (2020, February 26). *grapes*. *Encyclopedia Britannica*. <https://www.britannica.com/plant/grape>
- Bekker, S. J., Hoffman, J. E., Jacobs, S. M., Strever, A. E., & van Zyl, J. L. (2016). Ecophysiology, vigor, berry and wine characteristics of grapevines growing on and off heuweltjies. *South African Journal of Enology and Viticulture*.
http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S2224-79042016000200004&lng=en&nrm=iso&tlng=en
- Bryan, C. (2017). *Expert Tips on How to Pack & Transport Wine • Traveling Corkscrew*.
<https://travellingcorkscrew.com.au/blog/expert-tips-pack-transport-wine/>
- Cata. (2016). *¿Se produce vino en Colombia?. - CataDelVino.com*.
<https://www.catadelvino.com/blog-cata-vino/se-produce-vino-en-colombia>
- Çetin, E. S., Altinöz, D., Tarçan, E., & Göktürk Baydar, N. (2011, July). *Chemical composition of grape canes*. *Industrial Crops and Products*.
<https://linkinghub.elsevier.com/retrieve/pii/S0926669011000641>
- Chaina. (n.d.). *Vitis vinifera L. Flowers of Chania*. Retrieved February 6, 2022, from
<http://flowersofchania.weebly.com/vitis-vinifera-l.html>
- Encyclopedia. (2019). *Grapes* | *Encyclopedia.com*. CENGAGE.
<https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/grapes>
- FAOSTAT. (2022). *FAOSTAT*. <https://www.fao.org/faostat/en/#data/QCL/visualize>
- Gerard, J. (2021). *How to Keep Up Grapevines to Produce Grapes*.
<https://homeguides.sfgate.com/keep-up-grapevines-produce-grapes-46674.html>
- Giese, G. (2020). *NMSU: Grapevine Phenology: Annual Growth and Development*.
https://aces.nmsu.edu/pubs/_h/H338/welcome.html

Goldmaer, T. (2018). *Grape Grower's Handbook: A Guide To Viticulture for Wine Production*. Apex Publishers.

http://www.wine-grape-growing.com/wine_grape_growing/wine_grape_growing_chapters/ch01_grapevine_growth.htm

Grant, A. (2022a). *Fertilizing Grape Vines—Learn About Plant Food For Grapes*.

<https://www.gardeningknowhow.com/edible/fruits/grapes/how-to-fertilize-grapes.htm>

Grant, A. (2022b). *Pollinating Grapes: Do You Need Two Grape Vines For Fruit*. Gardening Know How.

<https://www.gardeningknowhow.com/edible/fruits/grapes/grapevine-pollination-needs.htm>

Gwaltney- Brant, S. (2021). *Raisin and Grape Toxicosis in Dogs—Toxicology*. MSD Veterinary Manual.

<https://www.msdsmanual.com/toxicology/food-hazards/raisin-and-grape-toxicosis-in-dogs>

Hanuman Girl. (2016). *EnoViti: Parts of the Grape Berry*. *EnoViti*.

<https://enoviti-hanumangirl.blogspot.com/2016/12/parts-of-grape-berry.html>

Hellman, E. (2003). *Grapevine Structure and Function*. *Grape Grower's Handbook*.

Healthline. (2021). *Top 16 Health Benefits of Eating Grapes*.

<https://www.healthline.com/nutrition/benefits-of-grapes>

Jrank. (2022). *Grapes—Biology Of Grapes*.

<https://science.jrank.org/pages/3096/Grapes-Biology-grapes.html>

Kadri, S., El Ayed, M., Mabrouk, M., Limam, F., Elkahoui, S., Aouani, E., & Mokni, M. (2019).

Characterization, anti-oxidative effect of grape seed powder and in silico affinity profiling of polyphenolic and extra-phenolic compounds for calpain inhibition. *Journal of Pharmaceutical and Biomedical Analysis*, 164, 365–372. <https://doi.org/10.1016/j.jpba.2018.11.003>

Kahtar. (2022). Propagation of grapevines. In *Wikipedia*.

https://en.wikipedia.org/w/index.php?title=Propagation_of_grapevines&oldid=1067814834

Keller, M. (2019). *Stages of Grape Berry Development – Grapes*.

<https://grapes.extension.org/stages-of-grape-berry-development/>

Karlsson, B. (2021). *Wine Consumption In The World 2020 In Decline, A Detailed Look*.

<https://www.forbes.com/sites/karlsson/2021/12/31/wine-consumption-in-the-world-2020-in-decline-a-detailed-look/?sh=2f99648c3f71>

Karlsson, P. and B. (2022). *Wine Consumption In The World 2020 In Decline, A Detailed Look*.

Forbes. Retrieved April 27, 2022, from

<https://www.forbes.com/sites/karlsson/2021/12/31/wine-consumption-in-the-world-2020-in-decline-a-detailed-look/>

Lazcano, C., Decock, C., & Wilson, S. G. (2020). Defining and Managing for Healthy Vineyard Soils, Intersections With the Concept of Terroir. *Frontiers in Environmental Science*, 8.

<https://www.frontiersin.org/article/10.3389/fenvs.2020.00068>

Livingston, S. (2013). *World's oldest-known grape fossils found in India*. Florida Museum.

<https://www.floridamuseum.ufl.edu/science/worlds-oldest-known-grape-fossils-found-in-india/>

Mayflower. (2021). *How to Pack Wine Bottles | Moving Tips | Mayflower®*.

<https://www.mayflower.com/moving-tips/blog/how-to-pack-wine>

Moriguchi, T., Kozaki, I., Matsuta, N., & Yamaki, S. (1988). Plant regeneration from grape callus stored under a combination of low temperature and silicone treatment. *Plant Cell, Tissue and Organ Culture*, 15(1), 67–71. <https://doi.org/10.1007/BF00039890>

NIBU.CO.UK. (2021). *Wine imports and exports | nibusinessinfo.co.uk*.

<https://www.nibusinessinfo.co.uk/content/wine-imports-and-exports>

- OEC. (2020). *Wine (HS: 2204) Product Trade, Exporters and Importers* | OEC - The Observatory of Economic Complexity. <https://oec.world/en/profile/hs92/wine>
- Olmo, H. P. (1937a). Chromosome Numbers in the European Grape (*Vitis vinifera*). *Cytologia, Fujii Jubilaei*(1), 606–613. <https://doi.org/10.1508/cytologia.FujiiJubilaei.606>
- Olmo, H. P. (1937b). Chromosome Numbers in the European Grape (*Vitis vinifera*). *CYTOLOGIA, Fujii Jubilaei*(1), 606–613. <https://doi.org/10.1508/cytologia.FujiiJubilaei.606>
- Palumbo, F., Vannozzi, A., Magon, G., Lucchin, M., & Barcaccia, G. (2019). Genomics of Flower Identity in Grapevine (*Vitis vinifera* L.). *Frontiers in Plant Science, 10*. <https://www.frontiersin.org/article/10.3389/fpls.2019.00316>
- Reisch, B. I. (2001). *Breeding Grapes—Grape Flowers*. Cornell Grape Breeding. <http://www.hort.cornell.edu/reisch/grapegenetics/breeding/crossing1.html>
- Silverside, R. (2015). *Soil Types That Matter For Grape Growing*. <https://sommelierschoiceawards.com/en/blog/insights-1/soil-types-that-matter-for-grape-growing-164.htm>
- Smith. (2011). *Grape | Diseases and Pests, Description, Uses, Propagation*. <https://plantvillage.psu.edu/topics/grape/infos>
- Smith, D. (2019). *Grape Disease Management Overview – Grapes*. <https://grapes.extension.org/grape-disease-management-overview/>
- Stallsmith, A. (2011). *How to Grow Grapes from Seed*. Hunker. <https://www.hunker.com/13426892/how-to-grow-grapes-from-seed>
- Statista. (2021). • *Wine consumption worldwide, 2020* | Statista. <https://www.statista.com/statistics/232937/volume-of-global-wine-consumption/>

Karime Assis: *Vitis vinifera*

Urska. (2017, May 30). Overview of Grapevine Structure and Function. *EVineyard Blog*.

<https://www.evineyardapp.com/blog/2017/05/30/overview-of-grapevine-structure-and-function/>

Wen, J. (2022). *ITIS - Report: Vitis vinifera* [Integrated Taxonomic Information System].

https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=28629#null

Wikipedia. (2021). Climate categories in viticulture. In *Wikipedia*. Wikipedia.

https://en.wikipedia.org/w/index.php?title=Climate_categories_in_viticulture&oldid=1049230628