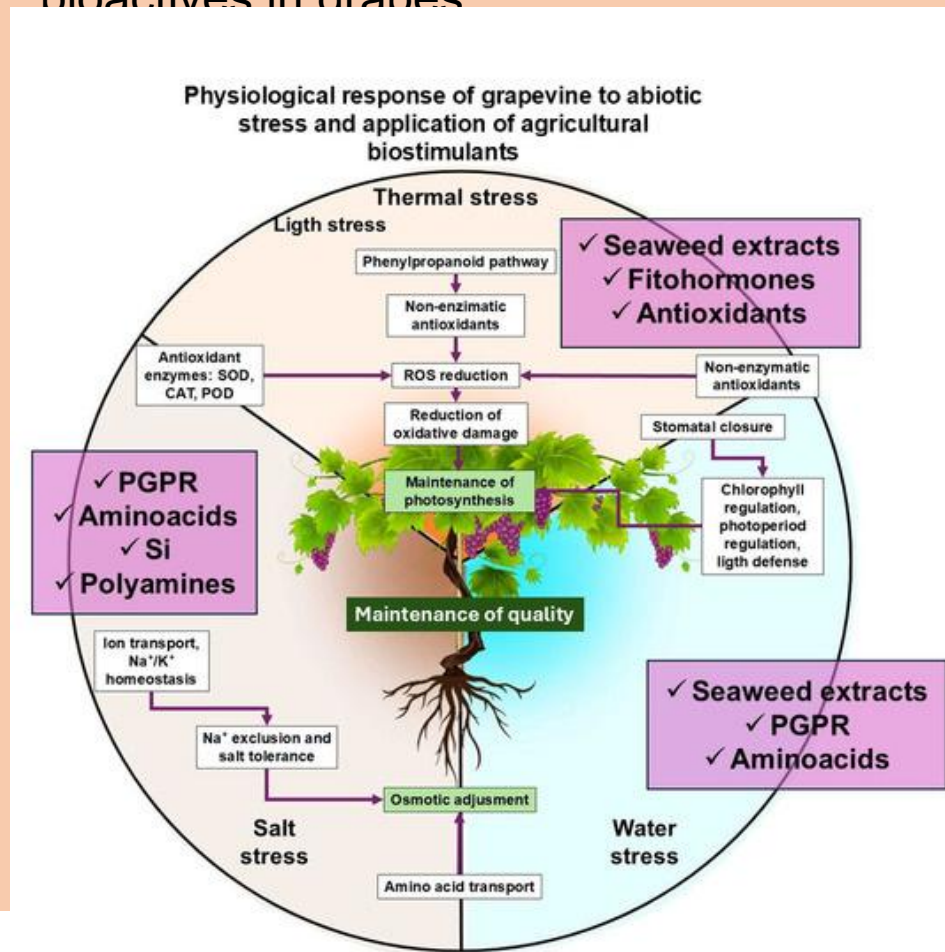


Impact of agronomic factors on grapes bioactive compounds

- Climatic conditions
- Soil type and
- Management practices

Verdugo-Gaxiola et al., 2025

<https://doi.org/10.3390/horticulturae11101261>



Impact of agronomic factors on grapes bioactive compounds

Climatic conditions - Temperature

- Grapevines thrive best in warm, dry summers and cool winters. The mean maximum temperature of the warmest month should be above 18-20°C, and above freezing in the coldest month. High humidity can increase disease and pest risk, while rain or cloudy conditions during blooming can lead to poor fruit set.
- **Temperature** is the most critical factor for grapevine growth. Grapevines thrive when average daily temperatures during the growing season range between 25°C and 32°C (77–90°F), which supports optimal photosynthesis, sugar accumulation, and acid balance in the berries. Extreme heat above 35°C can reduce photosynthesis, thicken berry skins, and negatively affect fruit quality, while cool climates may slow ripening and result in higher acidity ([Climatic Requirements for Growing Grapes - Agriculture Notes by Agriculture.Institute](#))

Impact of agronomic factors on grapes bioactive compounds

Ideal temperature conditions:

Temperatures range from 12 to 22°C during the growing season (April 1st to October 30th in the Northern Hemisphere and October 1st to April 30th in the Southern Hemisphere) Climate is the primary driver of grapevine quality, yield, and global geographical distribution. Seasonal fluctuations can significantly impact bunch number, berry weight, yield per vine, photosynthesis rates, transpiration, and berry composition. According to Malavaka et al., 2025, the optimal temperature for a grape variety refers to the range within which a grapevine can successfully complete its growth cycle—including budburst, flowering, veraison, and harvest—under favorable conditions. Warmer temperatures accelerate bud break, leading to earlier flowering and ripening. Conversely, colder temperatures can delay bud break, increasing the risk of frost damage [2].

Impact of agronomic factors on grapes bioactive compounds:

- **Soil type:** Different soil types affect grape growth and yield. Cover crops are grown to prevent wind or soil erosion, especially on sandy soils, and to minimize dust on the grape bunch. Grapes require soil that drains well to prevent waterlogging, which can damage roots and reduce fruit quality. Sandy loam, loamy sand, and gravelly soils are excellent choices because they allow water to move freely while retaining enough moisture for the vines to access during dry periods ([What Type Of Soil Is Best For Grape Vines? - Soil Selection Secrets – GardenerBible](#)).



Fig.1

Vineyard Soils



Sandy

- Drains well
- Retains heat

Wine has...

- Less color
- Less acidity
- Less tannin
- More aroma



Clay

- Stays cooler
- Retains water

Wine has...

- Bold flavor
- Vivid color



Silt

- Retains water
- Retains heat

Wine has...

- Less acidity
- More aroma
- Smooth tannin



Loam

- Made of silt, clay, sand & humus

Wine has...

- Less color
- Less flavor

Impact of agronomic factors on grapes bioactive compounds:

- **Soil type:** The newest published results from the working group of Macías-Gallardo et al., 2025, indicated that the clay–humic complex enriched the vineyard soil, resulting in higher levels of moisture, clay, silt, EC, OM, P, N, Fe₂O₃, SiO₂, MnO, and TiO₂. These soil conditions promoted superior development of myricetin, quercetin, resveratrol, chlorogenic acid, and antioxidant capacity in the grape skins. Conversely, with the exception of catechin and chlorogenic acid, grape seeds exhibited higher concentrations of most phenolic compounds. Additionally, SY grapes showed higher levels of individual phenolics. Soil pH, clay, sand, OM, CaCO₃, and various oxides (Al₂O₃, K₂O, SO₃, MgO, and CaO) positively influenced the biosynthesis of individual phenolics and skin antioxidant capacity. Meanwhile, soil moisture, clay, EC, OM, P, and specific oxides (SiO₂, TiO₂, Al₂O₃, Fe₂O₃, and MnO) positively influenced individual phenolic content in the seeds, with the exception of resveratrol, quercetin, and kaempferol [3].

Grapes and Health — Online Module (Week 1): Session Distribution

Impact of agronomic practices and industrial processing on the stability of the bioactives in grapes

Impact of agronomic factors on grapes bioactive compounds:

- **Soil type:** Loamy soils, which are a balanced mix of sand, silt, and clay, provide good aeration and root penetration. Sandy soils warm up quickly in spring, promoting early fruit ripening, but may need organic amendments to improve nutrient and water retention. Clay soils retain moisture but can compact easily, so they are less ideal unless drainage is improved.
- pH Levels: Grapevines grow best in slightly acidic to neutral soils, typically with a pH between 5.5 and 6.5 for most varieties, though some sources suggest 6.0 to 7.0 for optimal nutrient availability. European wine grapes (*Vitis vinifera*) are sensitive to acidic soils below pH 5.6, while American varieties (*Vitis labrusca*) tolerate lower pH but may struggle in high-pH soils ([What Type Of Soil Is Best For Grape Vines? - Soil Selection Secrets – GardenerBible](#))

Grapes and Health — Online Module (Week 1): Session Distribution

Impact of agronomic practices and industrial processing on the stability of the bioactives in grapes

Impact of environmental conditions:

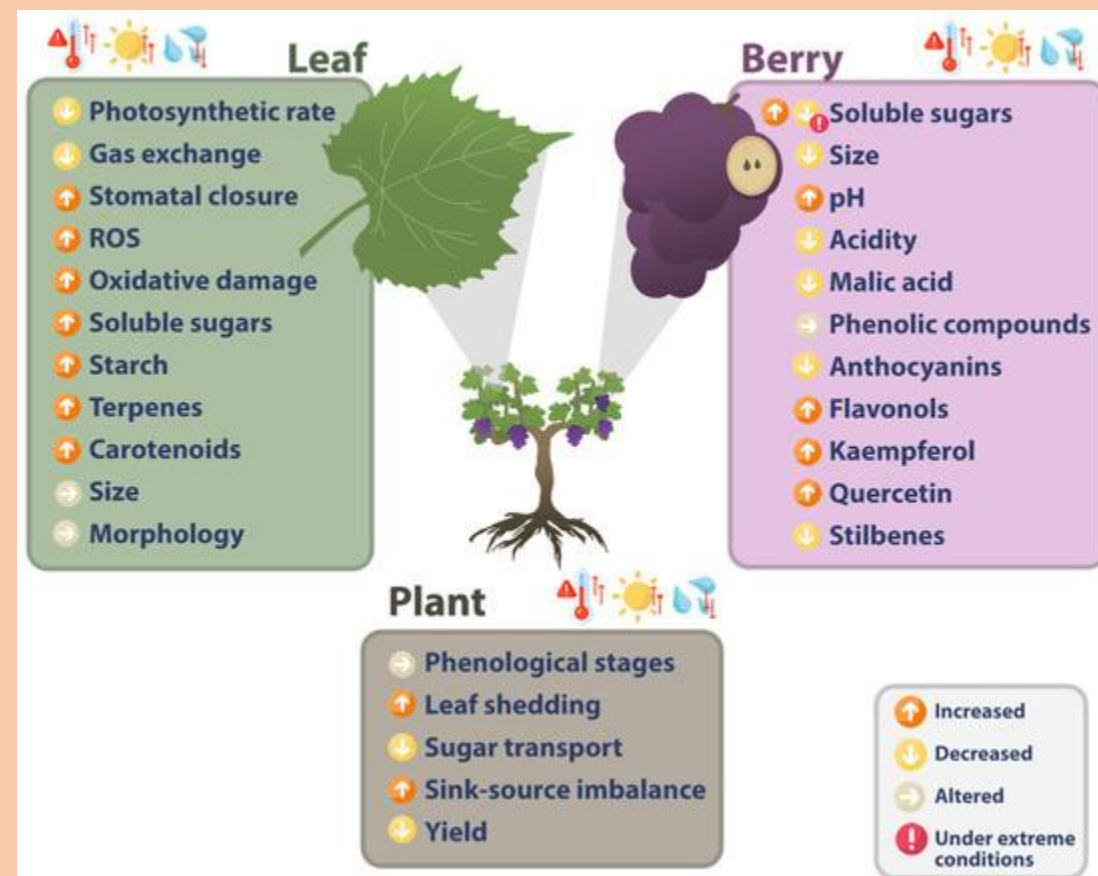
- According to Wang et al., 2022, environmental conditions, including light, temperature, and water availability, significantly influence the formation of primary metabolites—such as sugars and organic acids—and secondary metabolites, like anthocyanins, in grape berries. By altering the concentration and composition of these compounds, these external factors directly impact the berry's color and flavor profile [4].
- Proper management, including irrigation, cover crops, and nutrient management, is essential for maximizing grape production and quality. Moderate fertility is preferred. Overly rich soils can encourage excessive vegetative growth at the expense of fruit quality. Essential nutrients include nitrogen, phosphorus, potassium, and magnesium. Organic matter, compost, or well-rotted manure can improve nutrient availability and soil structure.

Grapes and Health — Online Module (Week 1): Session Distribution

Impact of agronomic practices and industrial processing on the stability of the bioactives in grapes

Baltazar M, Castro I, Gonçalves B. Adaptation to Climate Change in Viticulture: The Role of Varietal Selection—A Review. *Plants*. 2025; 14(1):104.

<https://doi.org/10.3390/plants14010104>



Why industrial processing is necessary for the stability of the bioactives in grapes?

Table grapes are highly perishable and prone to postharvest deterioration. Their thin skins and high juice content make the berries delicate and susceptible to mechanical injury and microbial infection. Following harvest, grapes rapidly lose moisture through their skins and stem attachments (the rachis and pedicels), leading to rachis desiccation and browning, berry shriveling, weight loss, and a loss of firmness. Furthermore, the fruit is vulnerable to fungal decay; *Botrytis cinerea*, in particular, causes "gray mold," which can spread rapidly through grape clusters even in cold storage, resulting in significant spoilage [7].

Impact of industrial processing on the stability of the bioactives in grapes

Bioactive compounds in grapes vary in terms of cultivar and processing conditions. Raw juice and treated grape juices from locally grown Israel blue and locally available, imported, Red Globe and Michele Palieri varieties in Sri Lanka were used for the analysis in the work of Aponso et al., 2021. Grape juices were subjected to different processing conditions such as pasteurization and pectinase enzyme treatment. Total Monomeric Anthocyanin content (TAC), Total Phenolic Content (TPC), and antioxidant activity were analyzed. Compared to the imported grape varieties, the locally grown, pectinase enzyme-treated Israel blue grape juice with 2% pectinase enzyme concentration, 40 C incubation temperature, and 2 hours incubation time, under dark condition had the significantly highest of malvidin-3-O-glucoside, gallic acid equivalents and antioxidant activity [8].

How to retain the quality of grapes to avoid loss of bioactive compounds?

1. Boron, in the form of potassium tetraborate strongly inhibited spore germination, germ tube elongation, and mycelial spread of *B. cinerea* in the culture medium [9];
2. Essential oils from sweet basil, fennel, summer savory, and thyme effectively inhibited the mycelial growth of *B. cinerea*, a major cause of postharvest losses in table grapes. The results suggest that essential oils, especially those rich in phenolic compounds, could serve as safe and beneficial tools for preserving table grapes [10].
3. Another innovative approach involves the use of Citronella oil (CO) incorporated into soy protein isolate (SPI) to create antimicrobial protein films. These films exhibit strong potential for extending the shelf life of fresh produce. Notably, the film with 3% CO reduced grape weight loss to 44.16% after 7 days of storage, demonstrating its superior water-retention performance and applicability in food preservation [11].

How to stabilize the bioactive compounds from grapes during the industrial processing?

- Chitosan-tripolyphosphate (TPP) nanoparticles via ionic gelation to encapsulate concentrated hydroalcoholic extracts from grape juice and skin. More precisely, this industrial technique includes **microencapsulation** of coat grape extracts in core-shell powders or nanoparticles using carriers like maltodextrin or gums to shield sensitive polyphenols and anthocyanins from direct heat and oxygen [12];
- Restrict short-term heating operations (like **pasteurization**) to a safe window of 80 °C–100 °C where total anthocyanins remain relatively stable, avoiding severe degradation seen above 120°C [13];
- **Acidification** by careful addition of citric or acetic acid to adjustment fluids or extracts to lower pH, which naturally helps protect anthocyanin structure and color integrity during processing [13];
- **Enzyme Inactivation** by drying or processing temperature (around 60 °C) to properly inactivate polyphenol oxidase, an enzyme that otherwise accelerates phenolic breakdown at lower warmth (40 °C–50 °C) [14];

REFERENCES:

1. Verdugo-Gaxiola, S.E.; Diaz-Rubio, L.; Montañño-Soto, M.T.; Castro-López, L.d.R.; Castillo, G.; Córdova-Guerrero, I. Advances in Biostimulant Applications for Grapevine (*Vitis vinifera* L.): Physiological, Agronomic, and Quality Impacts. *Horticulturae* 2025, 11, 1261. <https://doi.org/10.3390/horticulturae11101261>
2. Malavika N, Saraswathy S, Muthuvel I, Djanaguiraman M, Jagadeeswaran R. Climatic factors affecting grapevine growth and production. *Plant Science Today*, 2025, 12(1), 01-07, DOI: 10.14719/pst.5482.
3. Macías-Gallardo F, Quiñones-Muñoz TA, Miranda-Avilés R, Ramírez-Santoyo LF, Zanor GA, Ozuna C. Impact of Organic Agriculture on the Quality of Grapes (Syrah and Tempranillo) Harvested in Guanajuato, Mexico: Relationship Between Soil Elemental Profile and Grape Bioactive Properties. *Agriculture*. 2025; 15(2):169. <https://doi.org/10.3390/agriculture15020169>.
4. Wang C, Wang L, Ye J, Xu F. Fruit quality of *Vitis vinifera*: How plant metabolites are affected by genetic, environmental, and agronomic factors, *Scientia Horticulturae*, 305, 2022, 111404, <https://doi.org/10.1016/j.scienta.2022.111404>.
5. Baltazar M, Castro I, Gonçalves B. Adaptation to Climate Change in Viticulture: The Role of Varietal Selection—A Review. *Plants*. 2025; 14(1):104. <https://doi.org/10.3390/plants14010104>

REFERENCES:

1. <https://onegrape.co.za/2025/05/20/the-effect-of-soil-types-on-wine-characteristics/>

7. Romero I., Vazquez-Hernandez M., Maestro-Gaitan I., Escribano M.I., Merodio C., Sanchez-Ballesta M.T. Table Grapes during Postharvest Storage: A Review of the Mechanisms Implicated in the Beneficial Effects of Treatments Applied for Quality Retention. *Int. J. Mol. Sci.* 2020;21:9320. doi: 10.3390/ijms21239320

8. Aponso, M .M. W., R. A. U. J. Marapana, A. T. Abeysundara, G. O. De Silva, and R. Manawaduge. 2021. “Effect of Different Processing Conditions on Bioactive Compounds of Selected Grape Varieties”. *Asian Food Science Journal* 20 (9):159-68. <https://doi.org/10.9734/afsj/2021/v20i930352>.

9. Qin, G.; Zong, Y.; Chen, Q.; Hua, D.; Tian, S. Inhibitory effect of boron against *Botrytis cinerea* on table grapes and its possible mechanisms of action. *Int. J. Food Microbiol.* 2010, 138, 145–150.

10. Abdolahi, A.; Hassani, A.; Ghosta, Y.; Bernousi, I.; Meshkatalasadat, M. Study on the potential use of essential oils for decay control and quality preservation of Tabarzeh table grape. *J. Plant Prot. Res.* 2010, 50, 45–52

11. Zhang C, Wang Q, He H, Wu Y, Shan W, Liu H. Postharvest Preservation Strategies for Table Grapes: A Comprehensive Review from Practical Methods to Future Developments. *Plants (Basel)*. 2025 Aug 8;14(16):2462. doi: 10.3390/plants14162462

REFERENCES:

12. Dos Santos Oliveira MO, Morais RA, Almeida Diniz DG, De Souza Martins HPGA, Asqueri ER. Nanoencapsulation of bioactive extracts from grape, jaboticaba, and hibiscus by-products using chitosan-TPP: Characterization, bioactive properties, and application in cassava-based foods, International Journal of Biological Macromolecules, 336, 2026, 149383, <https://doi.org/10.1016/j.ijbiomac.2025.149383>.
13. Botezatu, N., Covaci, E., & Arseni, A. Assessment of the effects of temperature and thermal treatment duration on the stability of phenolic constituents in sweet extracts produced from rara Negra grape marc. Journal of engineering science, 33(2), 2026, 100–112. [https://doi.org/10.52326/jes.utm.2026.33\(2\).08](https://doi.org/10.52326/jes.utm.2026.33(2).08).
14. Teles ASC, Chávez DWH, Gomes FdS, Cabral LMC, Tonon RV. Effect of temperature on the degradation of bioactive compounds of Pinot Noir grape pomace during drying. Braz. J. Food Technol. 2017, 21, <https://doi.org/10.1590/1981-6723.5917>.

Grapes and Health — Online Module (Week 1): Session Distribution

The grape and its derivatives: anatomy of the bunch, must, skin, seed and pomace.
Overview of the wine sector

Questions and discussion please

