Flowering and fruiting of grapevine

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Why flowering and fruiting of grapevine

Crop Value – Expenses = Profit (Income)

Yield

Number of cluster per vine

Number of berries per cluster

Bud break percentage

Bud Fruitfulness
(Number of fertile shoots related to unfertile shoots)

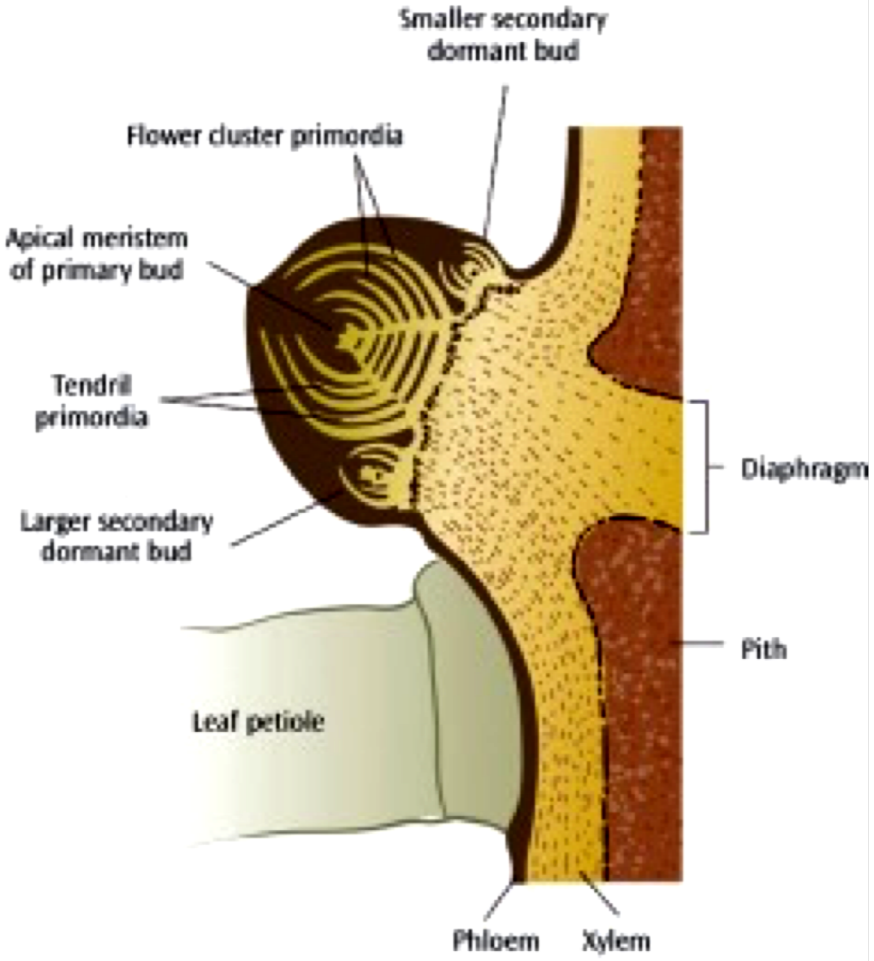
Quality

Cluster quality

Berry morphological quality

Berry organoleptic properties

Grapevine winter bud



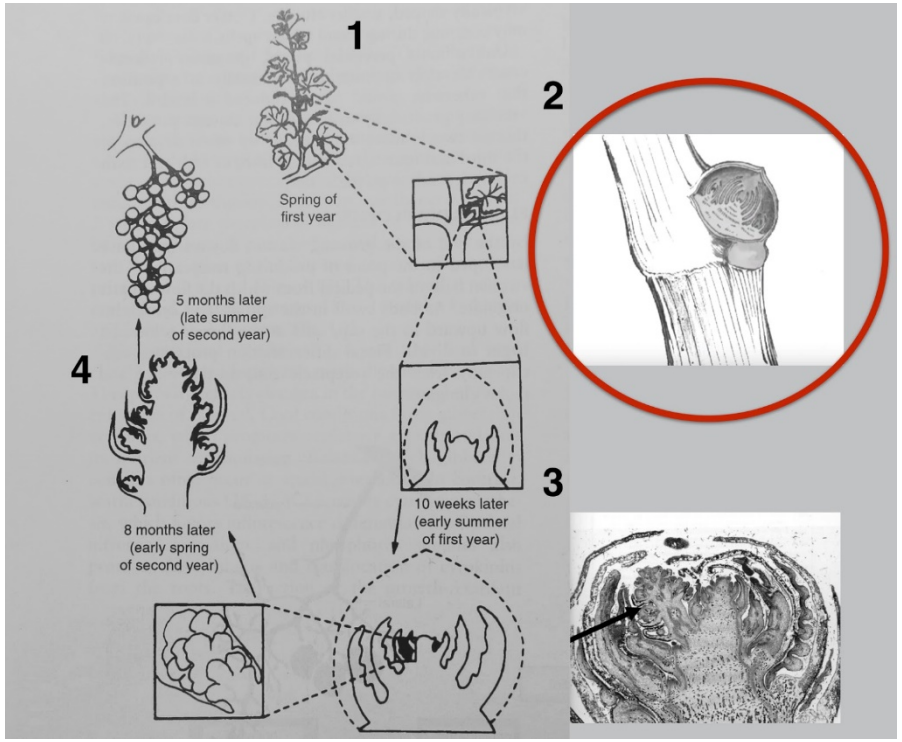
Li-Mallet et al 2015, Canadian J of Botany

Bud initiation and differentiation occurs during the growing season (From bloom up to harvest)

The winter buds, which were formed the previous season while shoots were growing, contain leaf and flower cluster primordia.

Bud formation and development is influenced by several physiological and environmental factors and cultural practices.

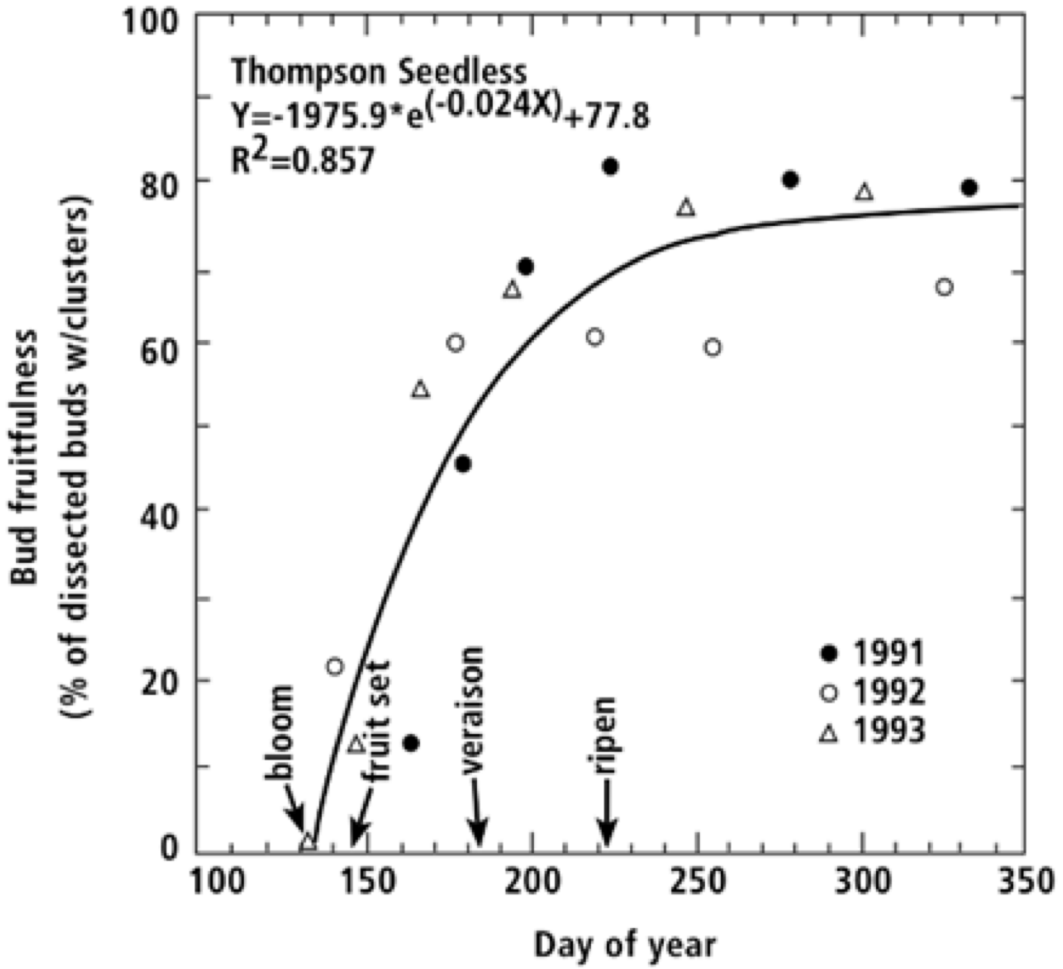
Bud differentiation and cluster primordia development



http://enoviti-hanumangirl.blogspot.com/2016/06/grapevine-inflorescence-formation-parts.html

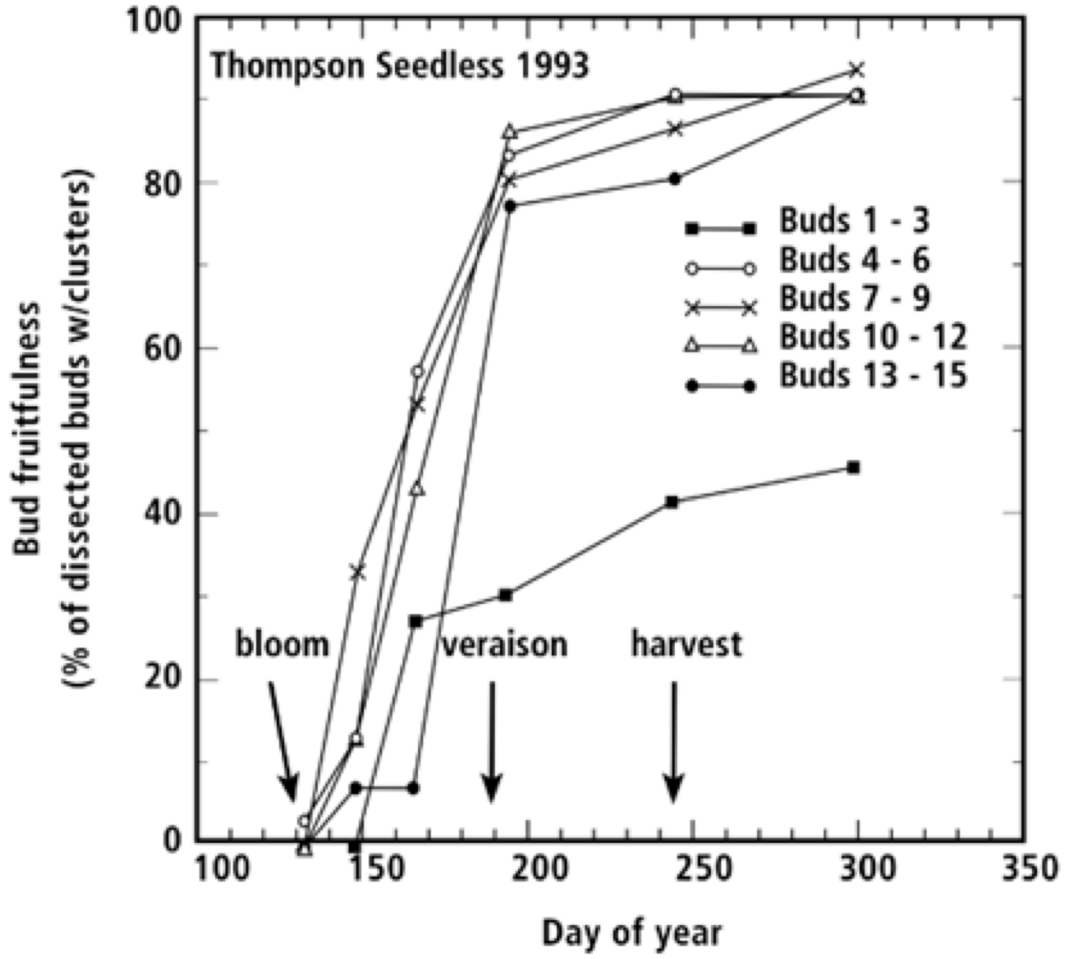
Growing the two crops successfully

Cluster differentiation during the growing season



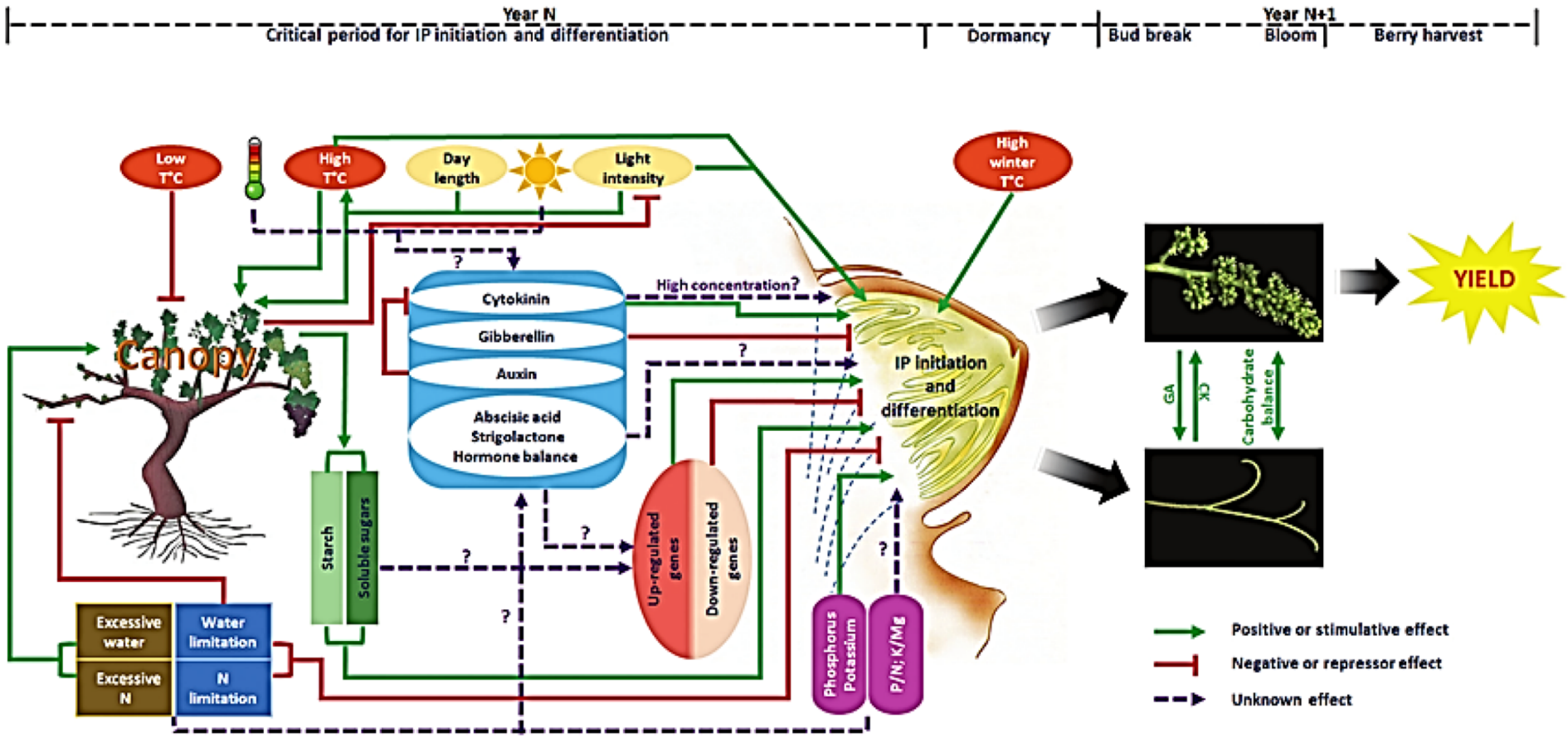
Larry Williams, Bud Development and Fruitfulness of Grapevines.

Bud position and Cluster differentiation in Thompson



Larry Williams, Bud Development and Fruitfulness of Grapevines.

Bud formation in grapes is influenced by several factors



Li-Mallet et al 2015, Canadian J of Botany

Conditions that reduce cluster number

Carbohydrates:

- Rapid growth and over-cropping accelerate using carbohydrates and reduce the number of clusters per shoot.

Nitrogen:

- Nitrogen is an essential element required for vine growth and development including keeping a good carbohydrates level.

- An excess of nitrogen stimulates canopy overgrowth and
- causes bud shading and reduce fruit bud formation and
- Produces flat canes with higher percentage of bud necrosis

Water supply:

- Water limitation reduces but differentiation and Excessive water produces large canopy with shaded buds and cases high risk of diseases. Especially if the water contains nitrogen.

Conditions that reduce cluster number

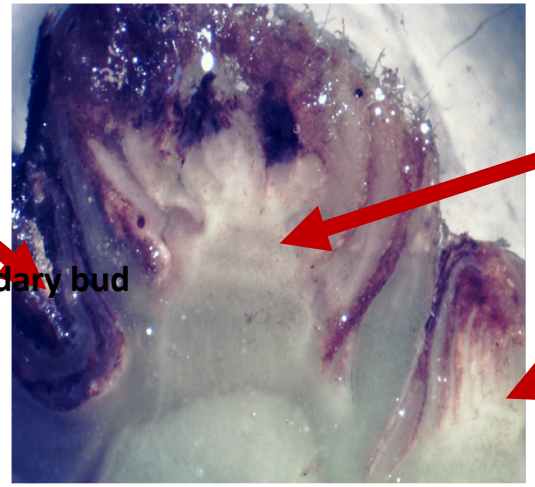
Environmental condition:

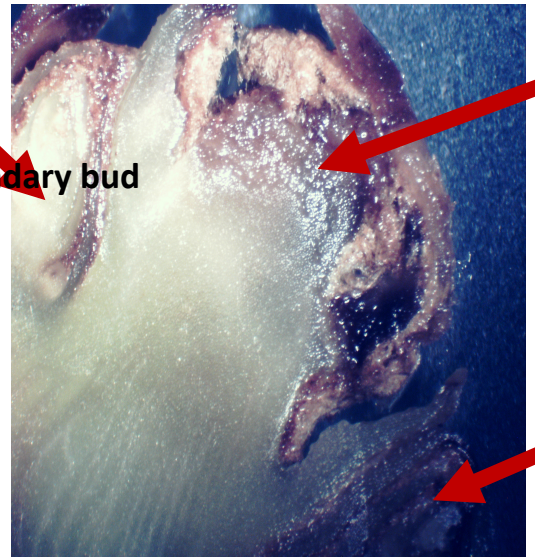
- Sunlight is required for bud differentiation and it is corelated with the bud fruitfulness.
- In the very hot region fruitfulness is reduced, probably due to lower carbohydrates level.
- Very cold winter and early spring frost cause bud mortality before bud break.

Cultural Practices:

- Pruning should be done according to the variety bud fruitfulness, we could leave more buds during pruning if high bud necrosis is expected.
- Selection of good spurs positions reduce bud shading and improve fruitfulness
- Canopy management such as shoot and leaf removal should be done professionally and on time.
- Trellis system and vine training should be done to expose the maximum of the canopy to sunlight and obtain high fruitfulness.
- Use high concentration of Gibberellic Acid (GA) in table grapes increases bud necrosis

Losing the main bud results in a low and an uneven bud break, and small clusters

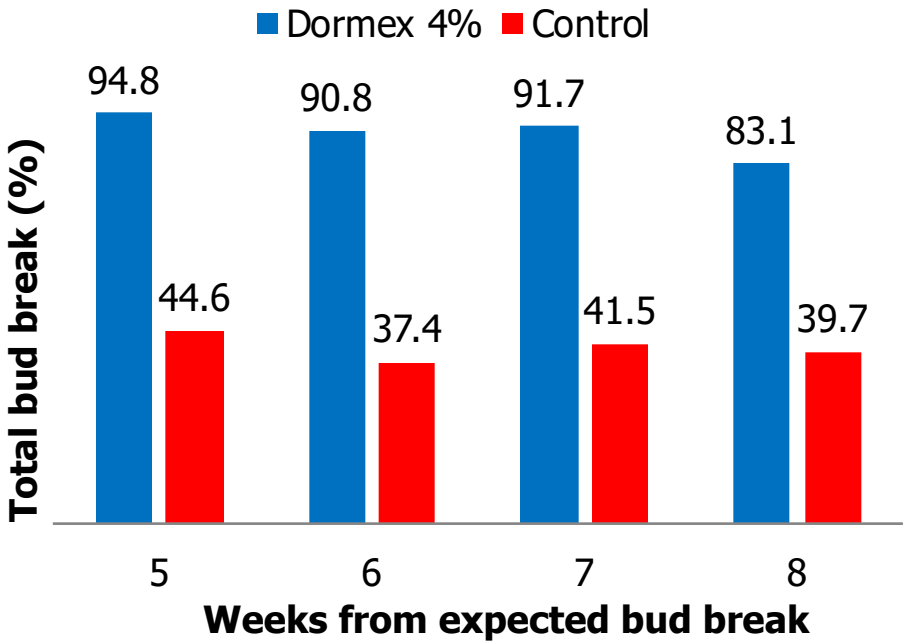




Losing the main bud results in a low and an uneven bud break

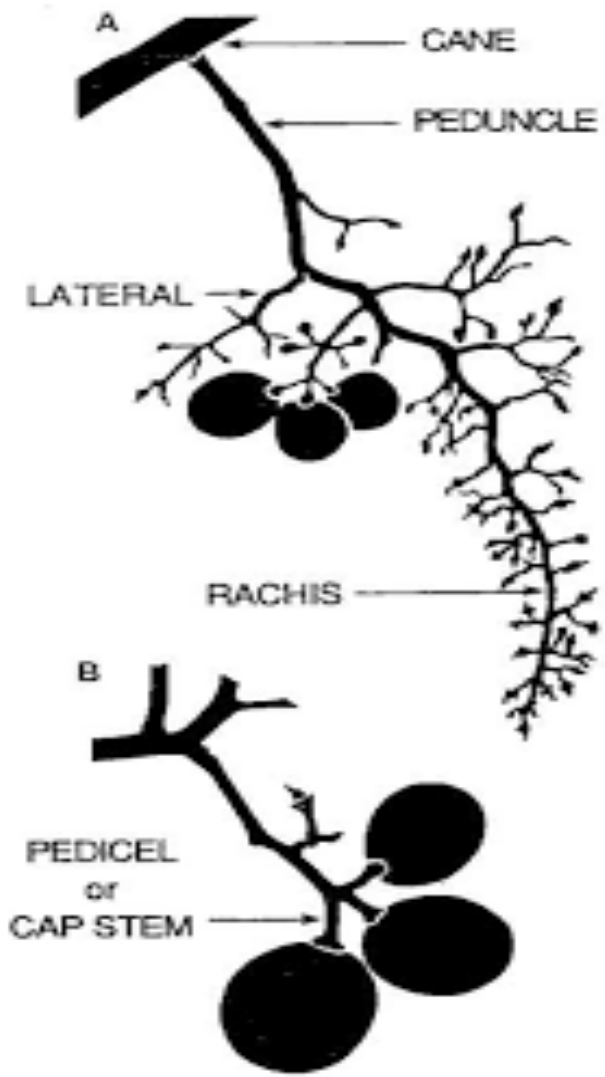
Dormex (Hydrogen Cyanamid) improves bud break and ripening of Flame seedless grapes

Budbreak in DORMEX® treated grapevines (left), showing advanced and uniform budbreak compared to untreated grapevines (on the right).

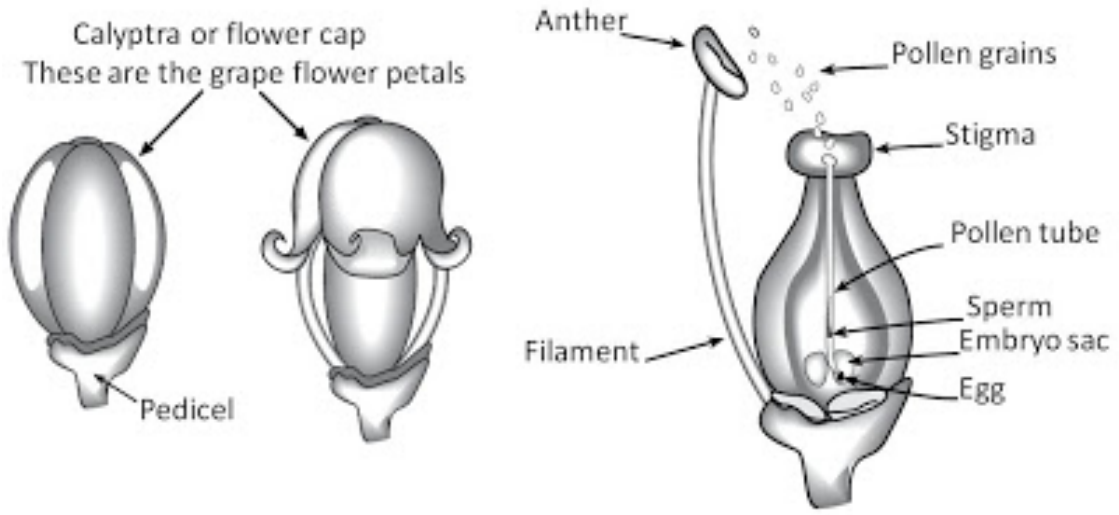


Earliness in bud Break (Days)	**14**	**14**	**21**	**21**
Earliness in harvest (Days)	**5**	**5**	**10**	**10**

Grapevine clusters



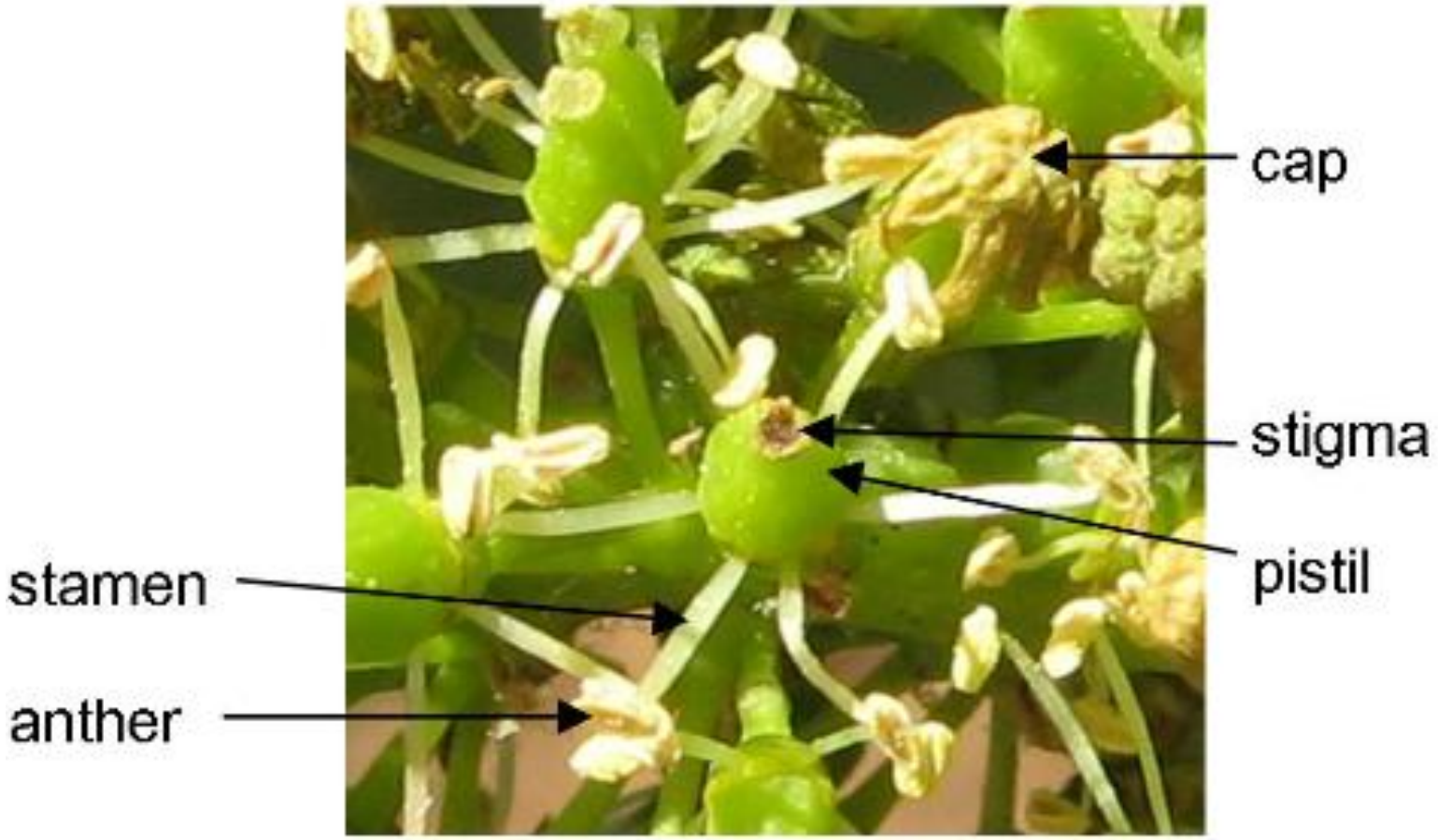
Grape perfect flowers



The **calyptra** or cap is actually the grape flower petals that cover the **stamen** (male---mnemonic for me is "men") and **stigma** (female---mnemonic for me is "ma") until **anthesis** or bloom when the calyptra detaches from the pedicel exposing the stamen and stigma. Bloom usually occurs from 6 to 8 weeks after budbreak. The bloom period is when things can get tricky and conditions must be just right for fruit set to occur:

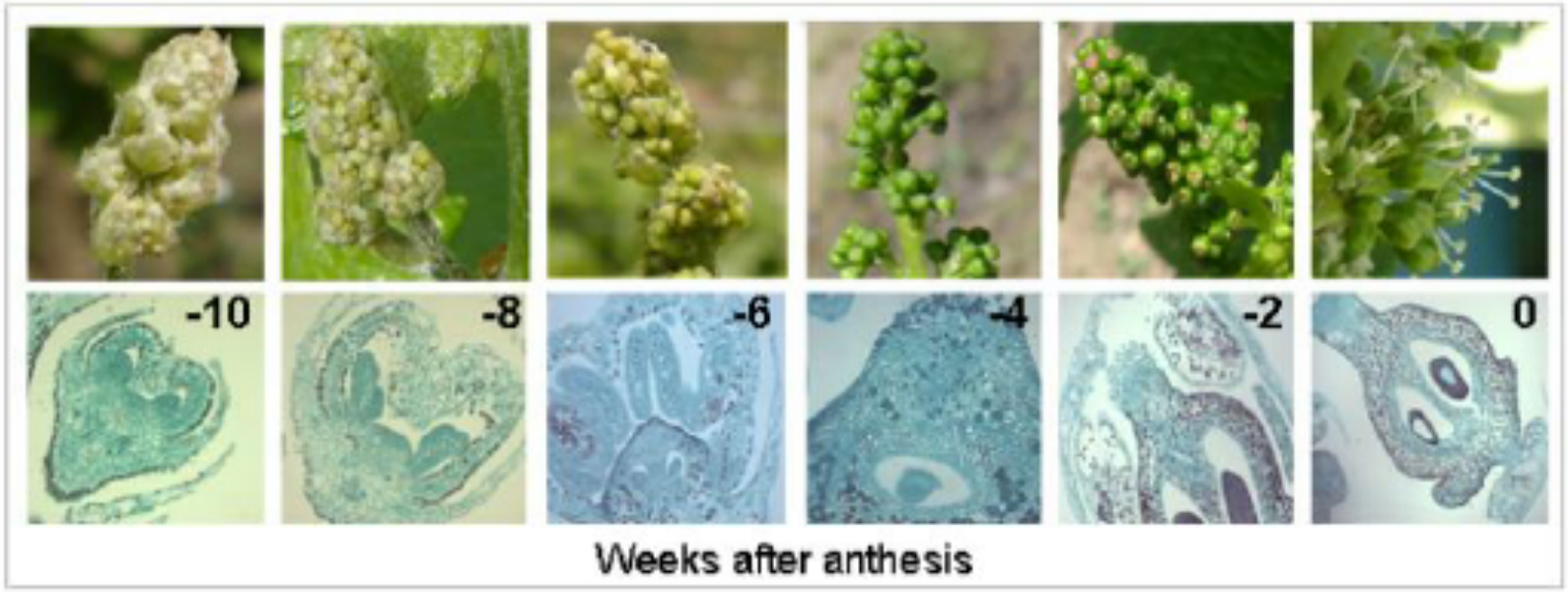
Nick K. Dokoozlian, Grape Berry Growth and Development.

Grape perfect flowers



An individual grape flower is shown with floral parts labeled.
Photo by Patty Skinkis, Oregon State University.

Flower development in grapevine



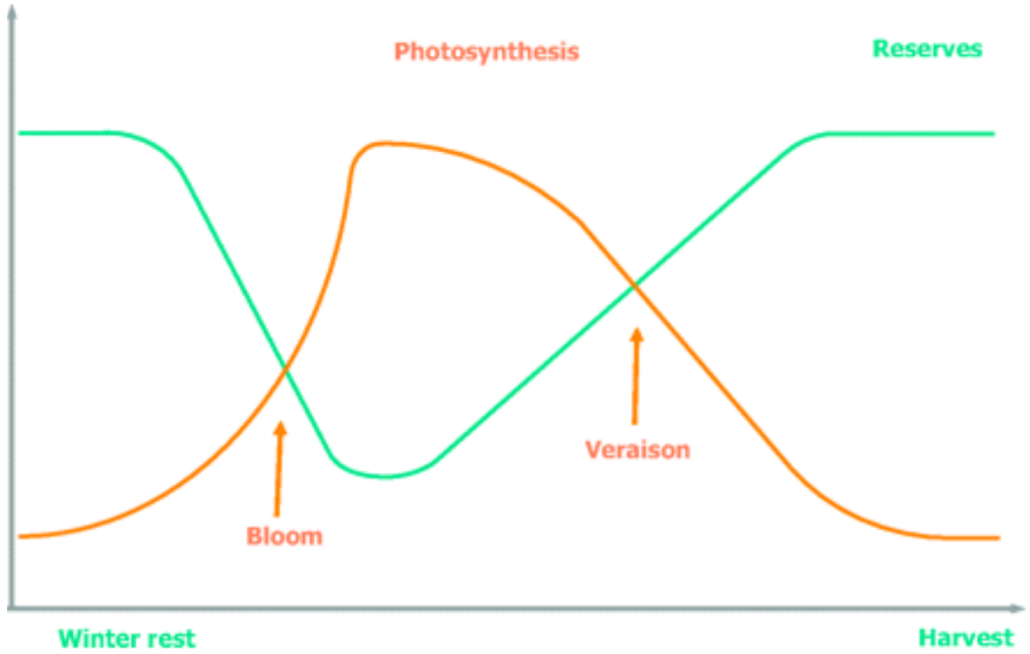
At 0 weeks the development of the seed is observed and the cap has detached from the flower and fallen apart.

Poupin, María & Matus, José & Leiva-Ampuero, Andrés & Arce-johnson, Patricio. (2011). Flower development in grapevine: A tale of two seasons.

Factors involved in reducing number of flowers per cluster after bud break

Carbohydrates use and accumulation

- Low carbohydrates reserve at bloom causes flower abscission and reduce the number of berries per cluster.
- To keep a good carbohydrates level, an optimum nutrition level should be used.



From: Sugars and flowering in the grapevine (Vitis vinifera L.)
J Exp Bot. 2008;59(10):2565-2578. doi:10.1093/jxb/ern135

Factors involved in reducing number of flowers per cluster after bud break

- Temperature is an important factor in germination and growth of the pollen tube. Fruit set is greatly reduced when temperatures fall below 65oF or exceed 100oF

- Cold temperatures, rainfall or high humidity are often associated with incomplete detachment of the calyptras leading to reduced fruit set

- Rain can dilute the stigmatic fluid and interfere with germination of the pollen grains and reduces fruit set

- High nitrogen level can cause flower abscission at bloom

- Using exogenous GA spray at bloom increase shattering

- Drought during bloom increases berry abscission

- Shaded clusters tend to have lower fruit set

Grape berry growth cycles

-First is formation cycle

•Berry formation start with cell division and flower starts transform into fruit.

•Water transfers into berry to enlarge berry.

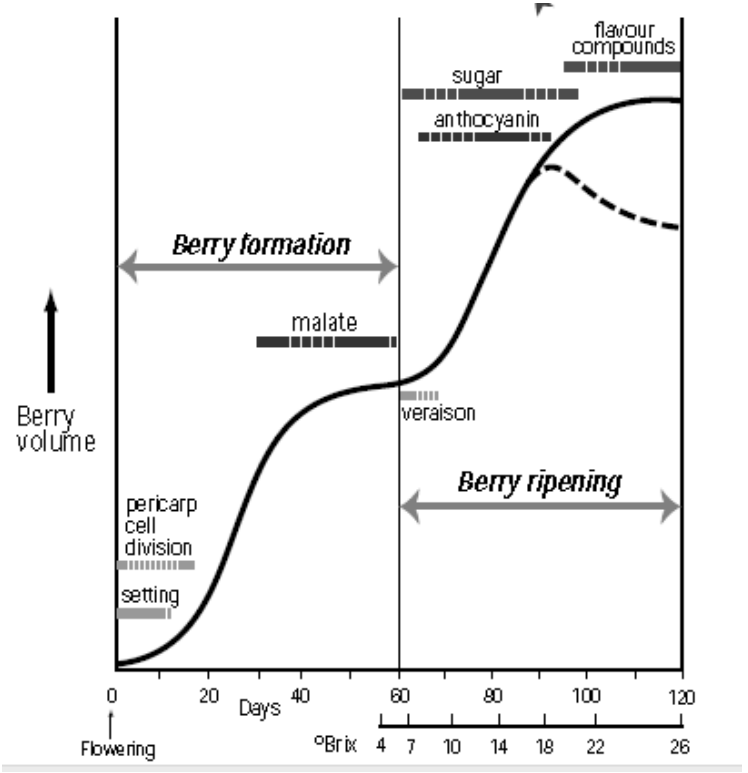
• Berry is green and hard, the volume increase rapidly.

-The second is ripening cycle

•Sugar accumulation, phenolics and flavour compounds

•Color changes from green.

•Formation of each compound is temperature and light depended



❑ ***These cycles are controlled by the plant hormones***

Hormones vs Growth Regulators

Plant hormones:

- Endogenous organic compounds active at very low concentration
- Essential for regulating plant growth and development
- Produced in one tissue and translocated to another tissue
- Have a specific function at specific stage and concentration
- They act together in a complex pathway

Plant Growth Regulators (PGR):

- Natural or synthetic form of the plant hormones that can be used to control or modify plant growth and also called plant growth substances or growth factors

Plant hormones synthesis and their function

Hormone	*Where produced or found*	*Function*
Auxin	-Embryos -Meristems of apical buds and young leaves	-Stimulates stem elongation at low concentration -Delays color and ripening -Retards abscission
Cytokinin	-Roots	-Affects root growth -Stimulates cell division -Delays ripening and senescence -Increases fruit set
Gibberellins	-Embryos -Meristems of apical buds and young leaves	-Promote bud growth and seed germination -Promote cell elongation
Abscisic acid	-Leaves, stem, root and green fruits	-Inhibits growth -Closes stomata -Promotes dormancy -Enhances coloration
Ethylene	-Ripening fruits -Aging leaves and flowers	-Promotes fruit ripening -Promotes senescence -Improve coloration

Grape berry development is controlled by the plant hormones

Auxin	*****	***	*	*	*	*
Cytokinin	*******	******	**	*	*	*
Gibberellins	*******	******	*	*	*	*
Abscisic acid	*	*	******	***	*	*
Ethylene	*	*	******	***	*	*

Fortes et al. 2015, Molecules, 20, 9326-9343

Plant Hormones are classified under two major groups

Growth Promoters	Growth Retardants / Inhibitors
• Cytokinins • Gibberellins • Auxin	•Abscisic acid (Stress hormone) •Ethylene (Ripening / Senescence hormone)
Promote cell division and growth	Inhibit cell division and growth

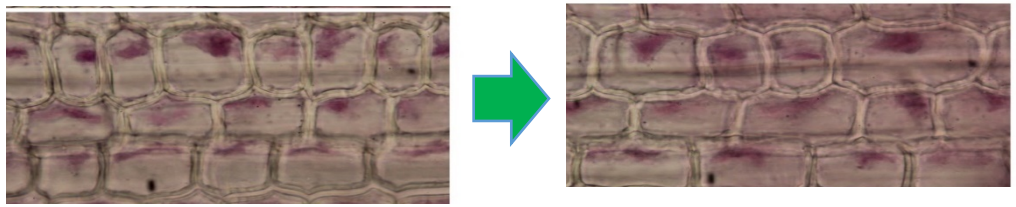
Mode of action of GA in increasing berry size

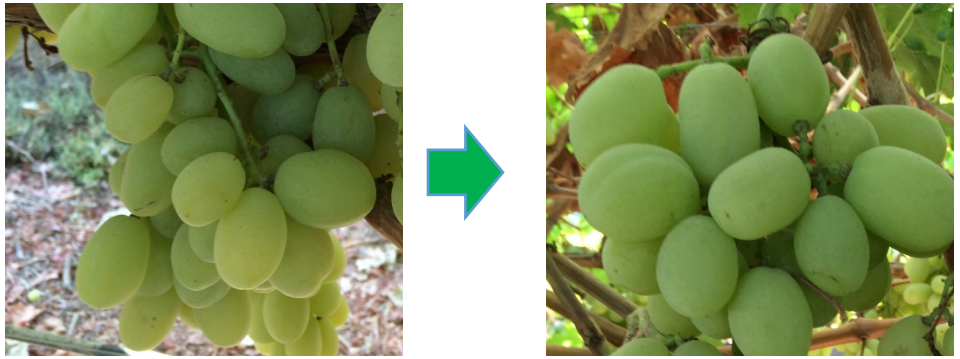
GA application

Cell elongation

Increases cell size

Increases fruit size





- GA

+ GA

Mode of action of Cytokinin in increasing berry size

Cytokinin application

↓

More cell division

↓

Increases number of cells

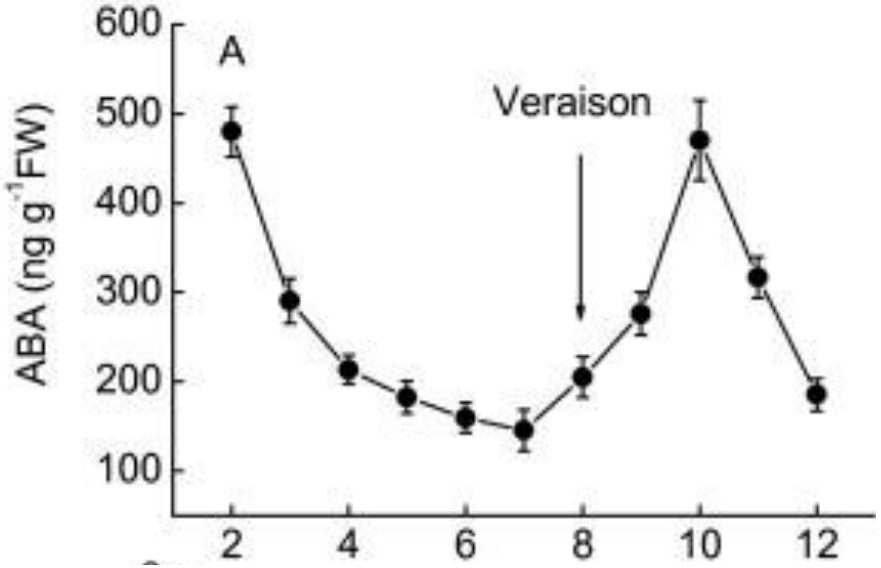
↓

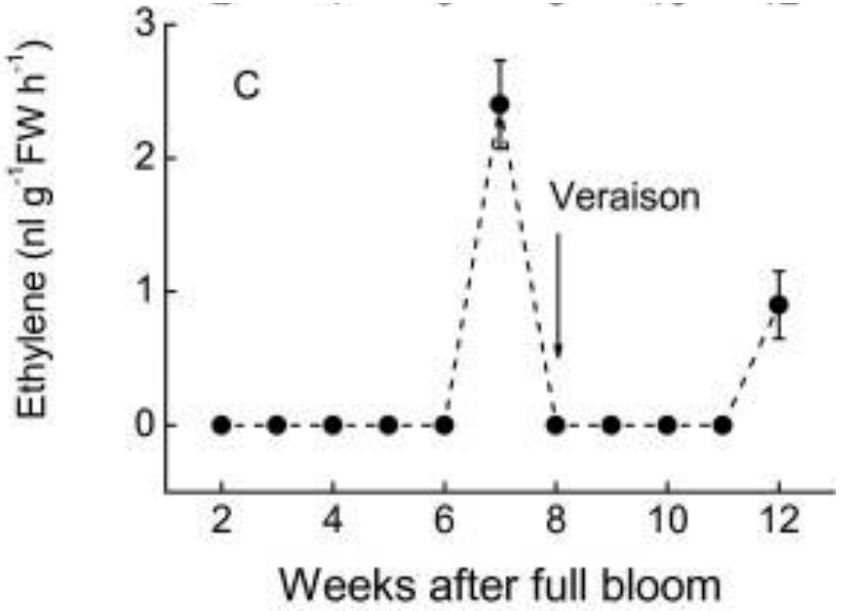
Increases fruit size

-CK

+CK

ABA synthesis during grape ripening

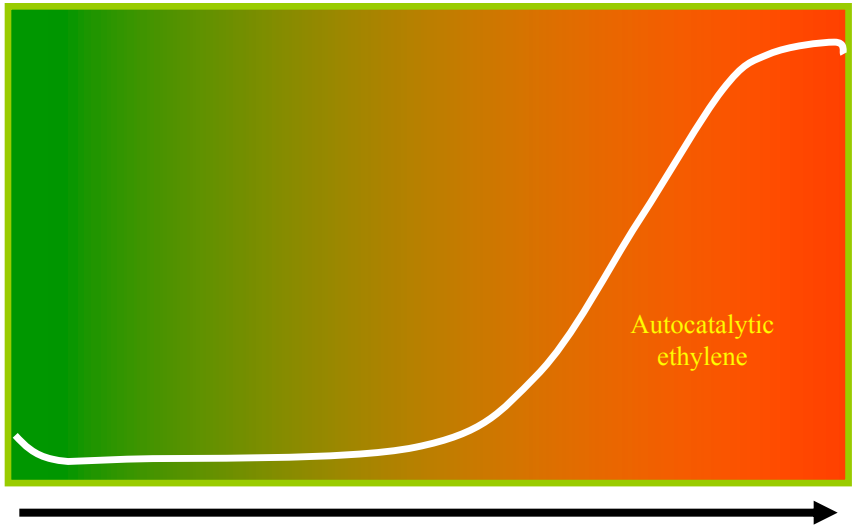




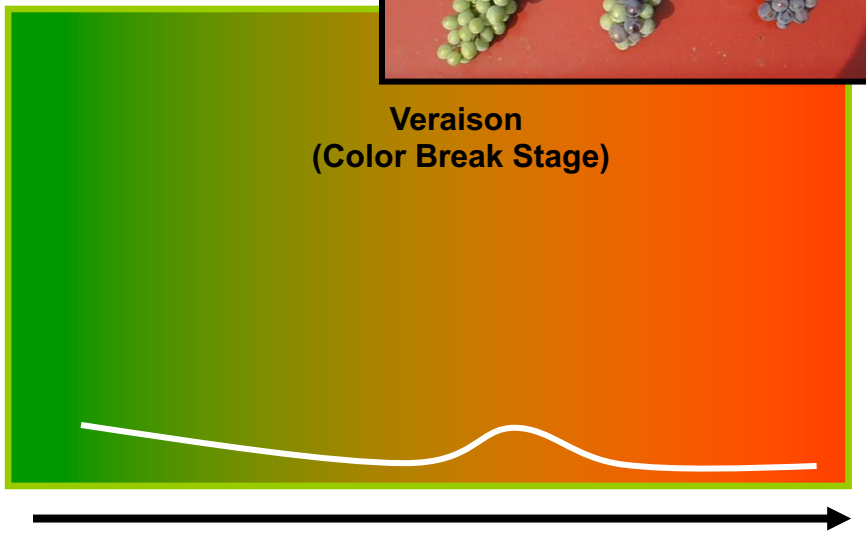
Sun et al., BMC Plant Biol. 2010; 10: 257.

Ripening of grape (Non-Climacteric fruit) Vs. tomato (Climacteric fruit)

EIM LMG MG Br Tu Orange Pink Red

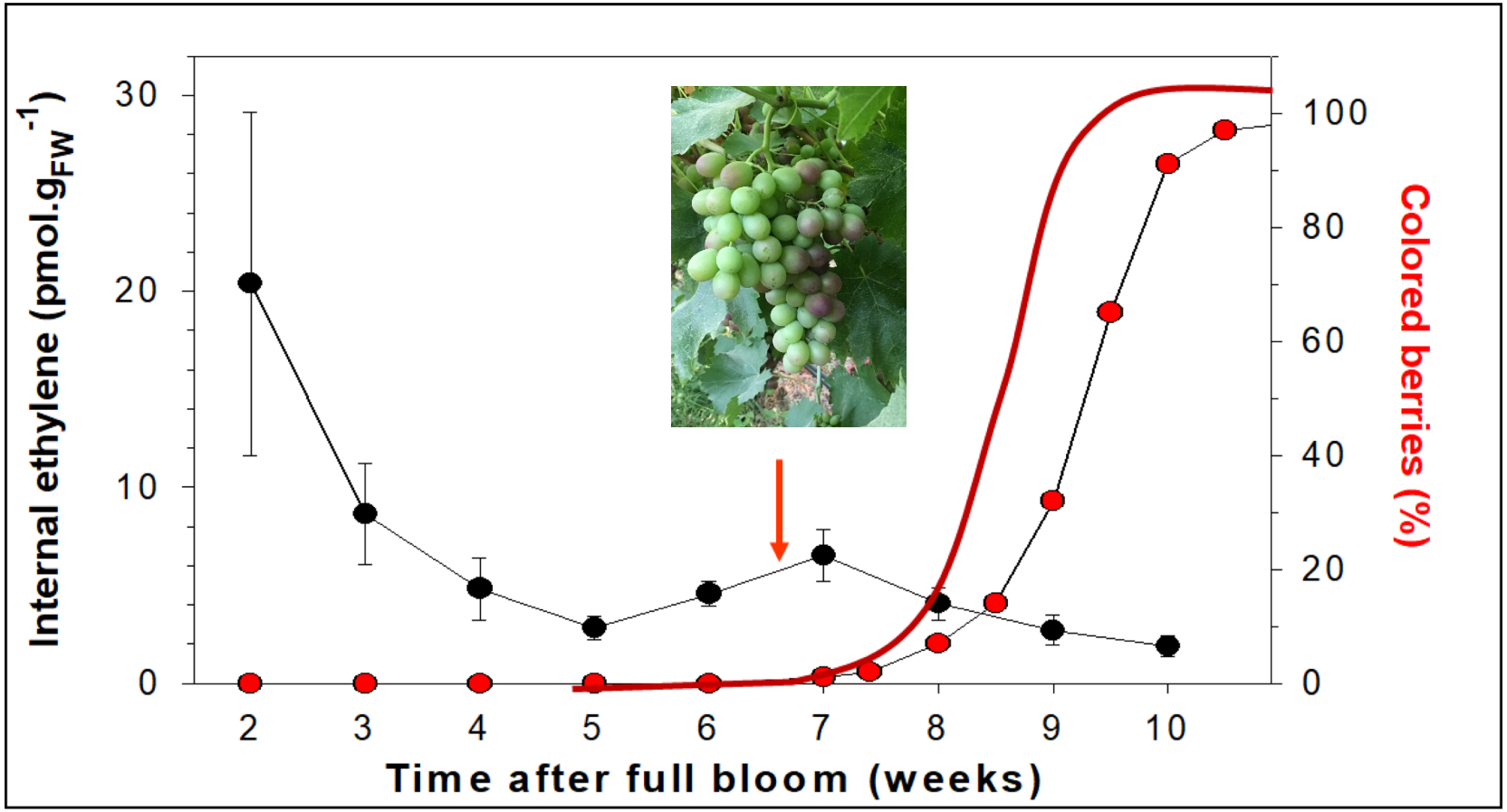


Veraison
(Color Break Stage)



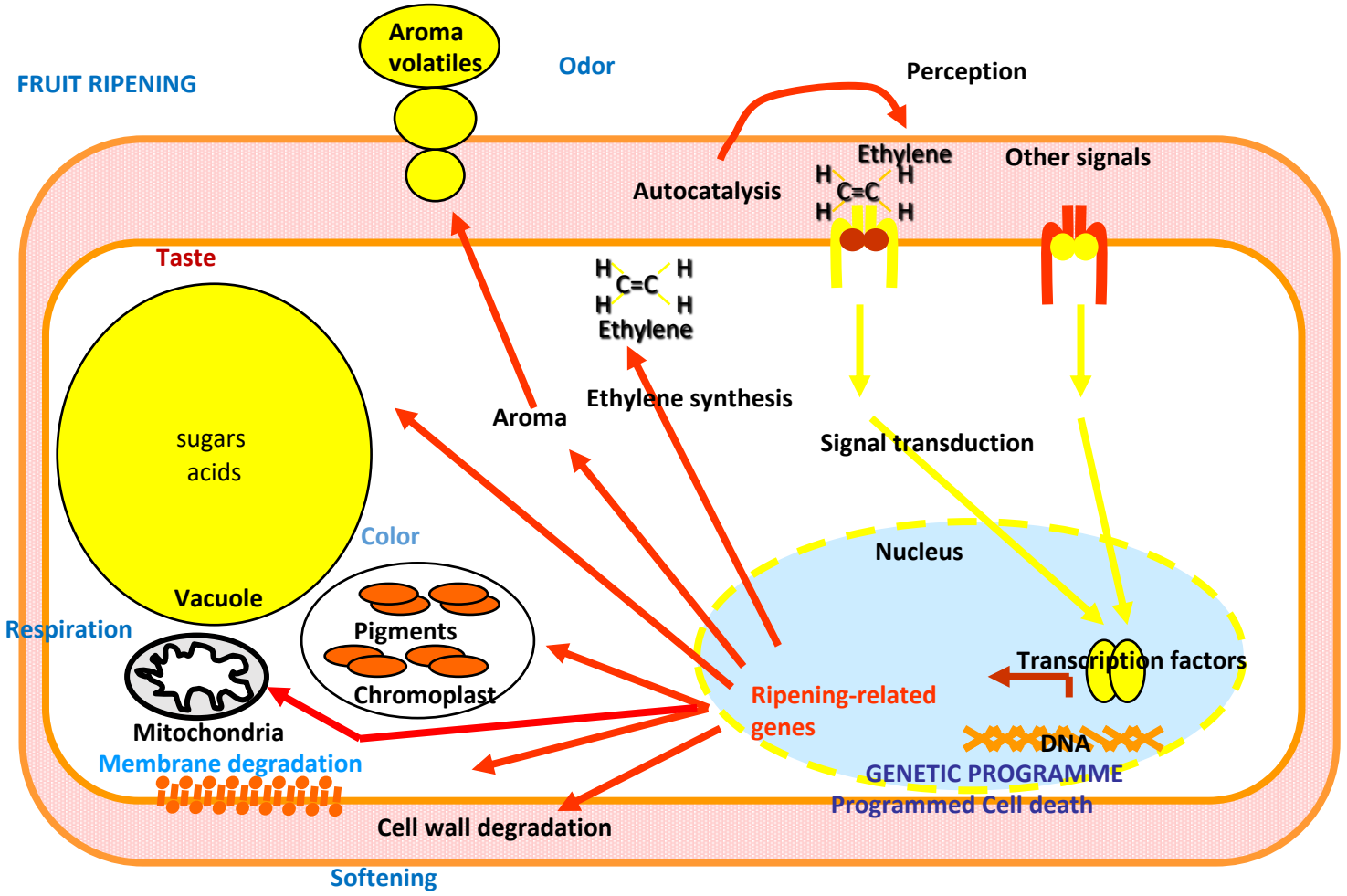
Combe and Hall, 1973.

Ethylene synthesis during grape ripening and its role in berry coloration

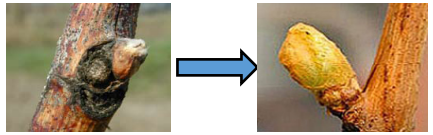


Plant Science, 2004, 167, 1301–1305

Role of the plant hormone ethylene in fruit ripening

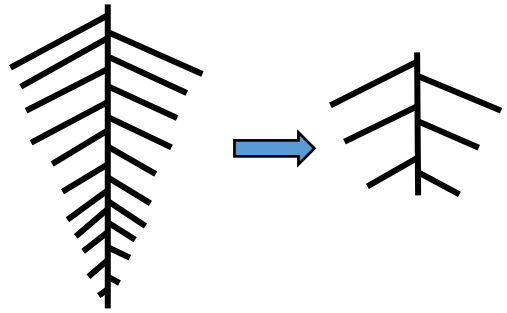


Production of table grapes with high quality

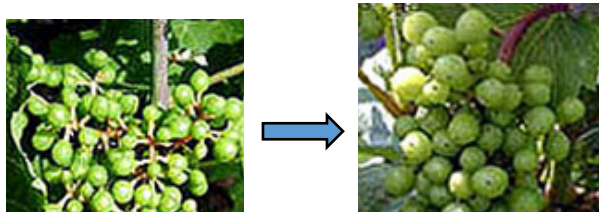


A good bud break

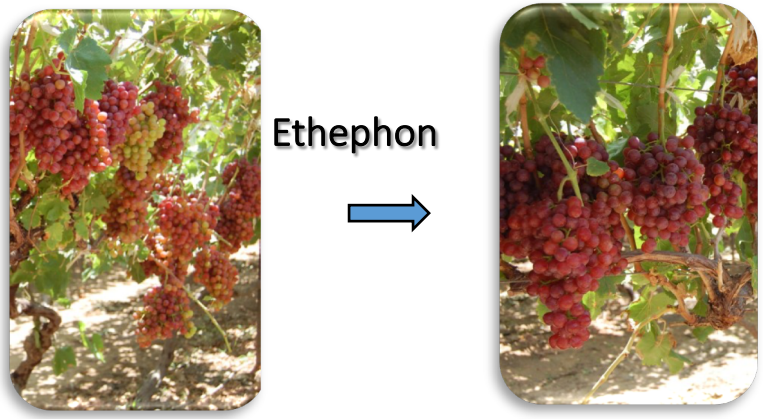
GA bloom spray to reduce number of berries per cluster



Manual cluster thinning in some cases



Sizing spray at pea size with GA or CPPU



Color spray in the red varieties

Plant Hormones and PGRs

Endogenous Hormone	Growth Regulators
Auxin	IAA, IBA, NAA, 2,4-D
Cytokinin	kinetin, BA, 2iP, TDZ
Gibberellin	GA_3, GA_{4+7}
Abscisic acid	ABA
Ethylene	Ethephon, Ethrel

General use of PGRs in table grapes

PGR	Purpose of use	Stage
❑ Gibberellins (GA)	Cluster elongation	Before bloom
	Berry thinning	Bloom
	Berry sizing	After fruit set
❑ Cytokinins (CK)	Berry sizing	After fruit set
❑ Abscisic acid (ABA)	Berry coloration	Verasion
❑ Ethylene	Berry coloration	Verasion

The effective concentration of each PGR varies among varieties.

Thanks

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