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Characteristics of Grapevine

Geographic-environmental groups of grapevine, life processes, growth and development

CHARACTERISTICS OF GRAPEVINE

Paleontological discoveries prove that vine plants emerged on Earth in Mesozoic era

Leaf blades of plants in the Vitis genus have a large number of veins, and are not divided

Most discoveries of the ancient plants, even from later eras, come from the Northern hemisphere (Canada, Siberia)

European species of the Vitis genus was found in France

Species of Vitis vinifera, subspecies silvestris (GRUMEL), ancestor to today's European grapevine cultivars, emerged in Pliocene at the end of the Tertiary

- True table varieties, with a large grape cluster and large berries, come from the Anatolia region and Central Asia, and represent a separate family of oriental varieties

- Expansion of Christianity has had positive impact on selection of varieties for production of quality wine; Islam has had a great impact on selection of grapevine for direct consumption of berries (Chasselas is one of the oldest grape varieties)

- Climbing vine plants evolved from plants which were probably shrubs and grew on steppes. Expansion of forests and decrease in steppe surface areas resulted in elongation of vine shoots; monopodial shoot branching became monopodial-sympodial, which allowed for permanent growth of the vine during growing season (shoot axis does not terminate with a flower, flowers develop alongside the main axis)

- One monopodial axis and two sympodial axes make up a 3-part unit; monopodium is always the shortest of the shoots, the first sympodium is always longer and the second sympodium is the longest
- Changes in branching gave way to emergence of climbing vine plants (leaves at the top of the crown were exposed to sunlight)
- Apical dominance of the grapevine developed (the most vigorous growth occurs at the highest part of the plant; basipetal movement of growth substances called auxins which stop growth of lower developed plant parts)

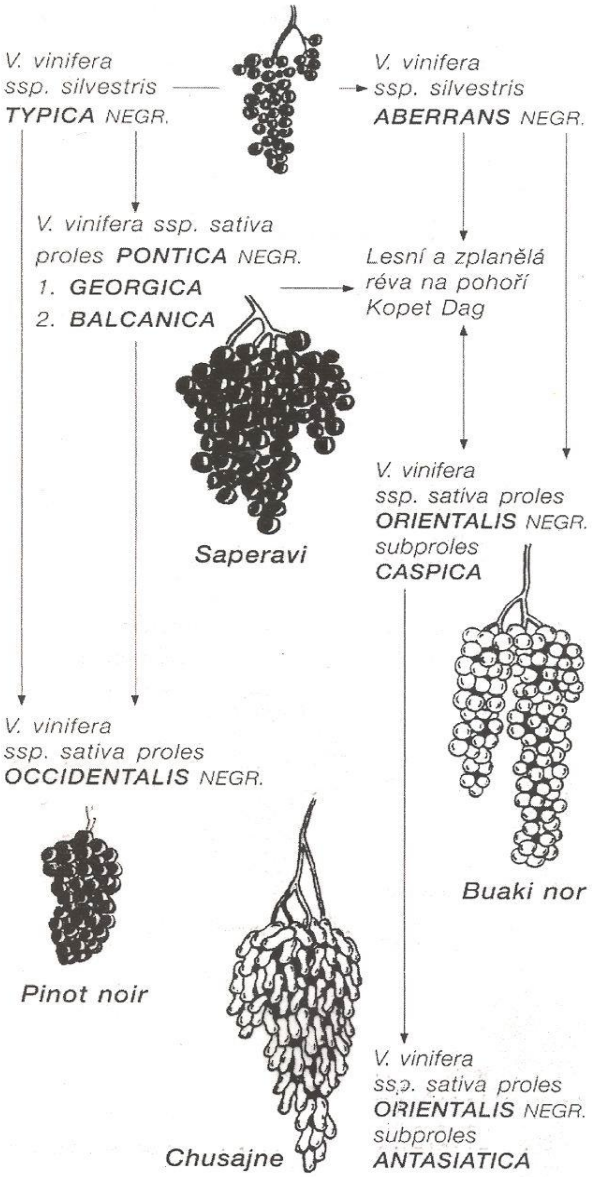
- Large crown is attached to a less vigorous trunk with a robust root system (important reserve organ) which penetrates deep into soil and is responsible for water and nutrient intake
- Over the winter, some of the reserve substances are stored in the nodes, close to the buds, and are available for rapid development of shoots. Buds break relatively late but the spring development is rather rapid

- Leaves are large, with thick venation which is responsible for quick water supply and assimilates circulation. Assimilation is a source for shoot growth, rapid fruit development and abundant supplies of sugar to fruits
- Transpiration and quick water transport in tissues help transport water and nutrients over long distances
- Highest water requirements: Before bud break, after blossom loss, and before verasion
- Major growth feature (wild growth, no training): Gradual death of congested and heavily branched tiers in the lower parts of the vine and constant growth of new, higher positioned tiers

- Growth and productiveness are very closely related. Productiveness of each shoot is determined by conditions in the previous growing season. All developed buds may be potentially productive.

- If the weather is good and shoots receive enough sunlight during the establishment of inflorescences for the upcoming season, and at the same time the yield is proportionate to the vine vigour, there is no periodicity in productiveness.

GENEALOGIE RÉVY VINNÉ



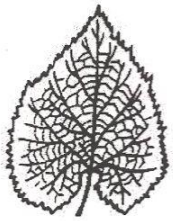
GENEALOGIE RODU *Vitis*

Prahory
Prvohory

Trias
Jura: Vznik semenných rostlin

Křída: ***V. dakotana*** *BERRY*

Druhohory



Paleocén

V. olrikii *HEER*

Eocén

V. sezannensis *SAP.*

Oligocén

V. teutonica *A. BR.*

Miocén

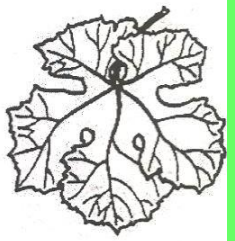
V. praevinifera *SAP.*

Pliocén

V. vinifera *ssp.* ***silvestris*** *GMEL.*

Čtvrtohory

V. vinifera *L.*



GRAPEVINE – characteristic features

- Growth patterns, vine character, rapid elongation of vertical axes in the direction of sunlight
- Polarity – apical dominance
- Deep root system
- Reserve substances stored in vine shoots (nodes, diaphragm)
- Heat-demanding, buds break at 10 °C average temperatures
- Growth speed – fast growth in a first half of the growing season

- Low specific weight of above-ground plant parts
- Intensive course of life processes
- Solid water regime
- Control of amount of breaking buds
- Gradual death of congested plant parts
- Productiveness of each shoot is determined by conditions in the previous growing season

Origin, classification and expansion of the Vitis L. genus

- Long development in forests of Europe, Asia, and America
- Vine, plenty of light for assimilation
- Forest conditions initiated specific morphological and physiological characteristics

- The Vitaceae Family comprises mostly tropical and sub-tropical species
- According to GALETA 1988, there are 18 Vitaceae families
- Vitis L. is the economically most important genus as it is used for grape and wine production all over the world
- Ornamental plants: species of Cisssus L., Ampelopsis PLANCH., Ampelocisus PLANCH., Parthenocissus PLANCH.

Significance, classification

- Classification of the Vitis genus have undergone many changes, several of botanically identical species were assigned various names
- French botanist PLANCHON conducted first classification of the Vitis genus, and distinguished between American and Asian Vitis ssp.
- Planchon's classification is important for vine cultivation as it differentiates between two subgenera:
  - ✓ Euvitis
  - ✓ Muscadinia
- GALET 1988 provides detailed differences between these two subgenera

EUVITIS subgenus

- All hybrids from crossings between species of this subgenus are viable and fertile
- Bark on shoots flakes in long stripes
- Secondary phloem consists of alternating layers of hard and soft phloem
- Secondary wood is soft, vessels are large
- Cross section of the shoot is always elliptic, never square
- Diaphragm constricts pulp in nodes

- Two- to three-forked tendrils grow opposite the leaves
- Wavy setulose hairs on vegetative organs
- Clusters have many berries which are attached to the peduncle till full maturity; berries have adequate acid and sugar content for direct consumption
- Seeds are pear-shaped
- Species of this subgenus may be used for mutual grafting
- Grafting with Muscadinia genus or any other is not possible

MUSCADINIA SUBGENUS

- Hybrids from crossing of species in this sub-genus are viable and fertile
- Shoots have distinctive lenticels, bark does not peel off
- Phloem fibres are the innermost layer of the bark
- Hard wood, no large vessels
- Little pulp surface area
- No diaphragm, pulp is not constricted

- Simple or divided tendrils grow opposite the leaves
- Vegetative part of the plants is always glabrous
- Grape clusters have few berries which ripen unevenly and then fall off; berries are fleshy with little juice and sugar inside, unsuitable for consumption
- Sickle-shaped seeds
- Palmate leaves, mildly lobed
- Grafting has no practical use, unsuccessful

Muscadinia subgenus is problematic for cultivation; it comprises only 3 wild species

- Vitis rotundifolia (southeast USA)
- Vitis munsoniana (USA-Mexican border)
- Vitis popenoi (Mexico)
- Vitis rotundifolia is important for its disease-resistance, great taste and aroma

- Hybridization of Vitis vinifera and Vitis rotundifolia was a task for the 19th century breeders

Botanical species of Euvitis subgenus

- Important in today's viticulture and grapevine breeding
- Found in three major centres, groups formed:
  - North American
  - East Asian
  - Eurasian

- Eurasian group is the most significant group with Vitis vinifera L. being the most grown species

- In terms of breeding cultivars resistant to adverse biotic and abiotic agents, North American and East Asian are important groups

- North American species of Vitis spp. are still a primary source of novel characteristics

Characteristics and potential of use of American and Asian wild plants from the Vitis genus for breeding

Harmful agent	Resistance source
Grapevine mould	*V. riparia*, *V. rupestris* *V. labrusca*, *V. amurensis*
Powdery mildew	*V. riparia*, *V. berlandieri* *V. labrusca*
Grapevine grey mould	*V. riparia*, *V. rupestris*
Phylloxera	*V. riparia*, *V. rupestris* *V. cinerea*, *V. berlandieri*

Winter frosts	*V. riparia*, *V. labrusca* *V. amurensis*
Drought	*V. rupestris*, *V. berlandieri*
Soil salination	*V. berlandieri*

- Largest habitat of the wild Vitis spp. in Asia lies in China; China has diverse landscape with vast differences in soil, climate, terrain, etc.

- Following species represent the Eurasian group:
    - Vitis vinifera subsp. sativa D.C.- noble grapevine
    - Vitis vinifera subsp. silvestris Gmel. – forest grapevine

- Vitis vinifera subsp. silvestris grows in regions stretching from Spain to Turkmenistan

- It further differentiates into three sortotypes
    - Vitis silvestris typica
    - Vitis silvestris aberans
    - Vitis silvestris balcanica

Existing classification categorizes grapevine varieties into environmental-geographical groups (NEGRUL 1946)

Vitis vinifera subspecies sativa is divided into 3 groups which are called „proles“:

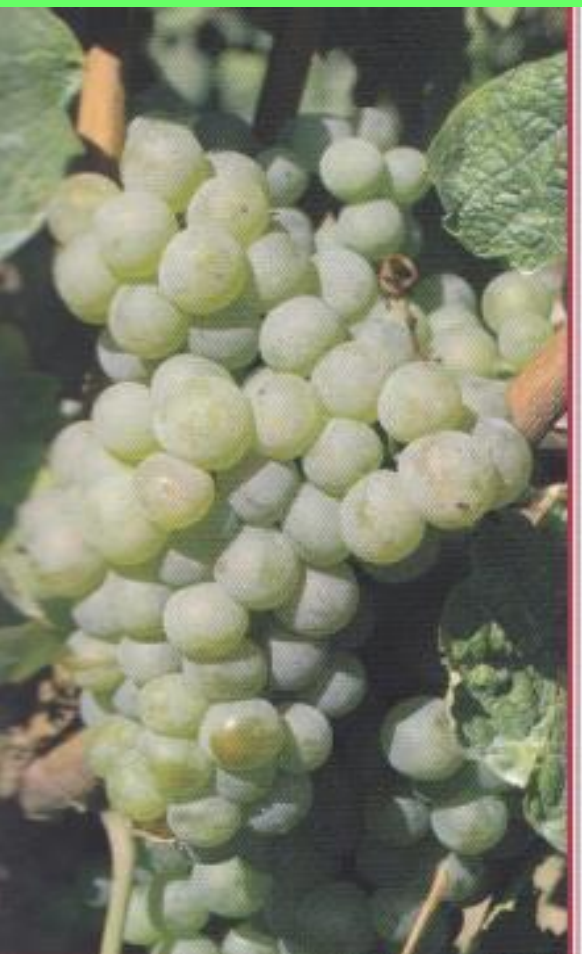
- Proles occidentalis (western group)
- Proles orientalis (eastern group)
- Proles pontica (Black Sea group)

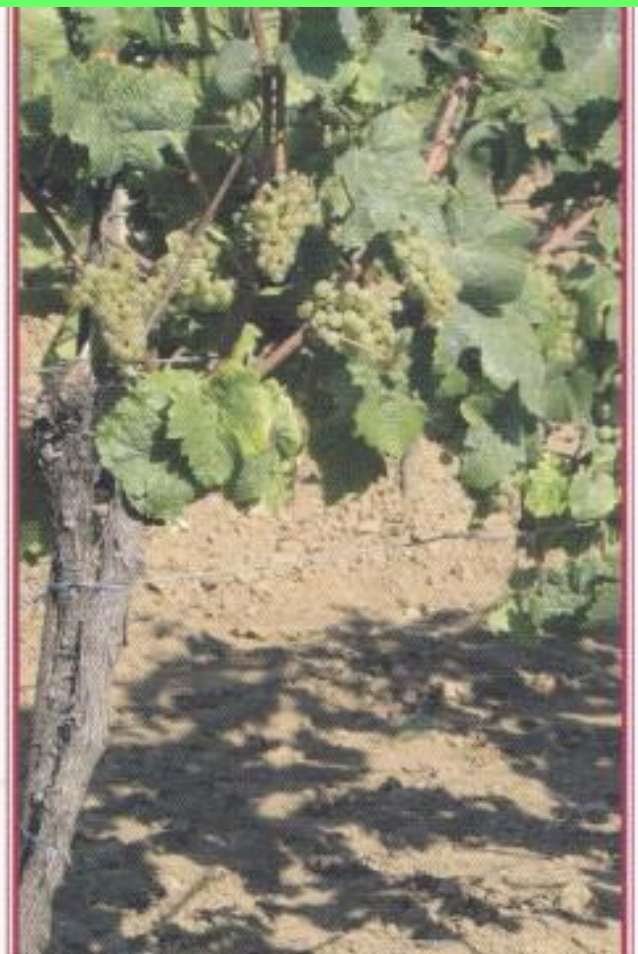
Characteristics of Proles occidentalis

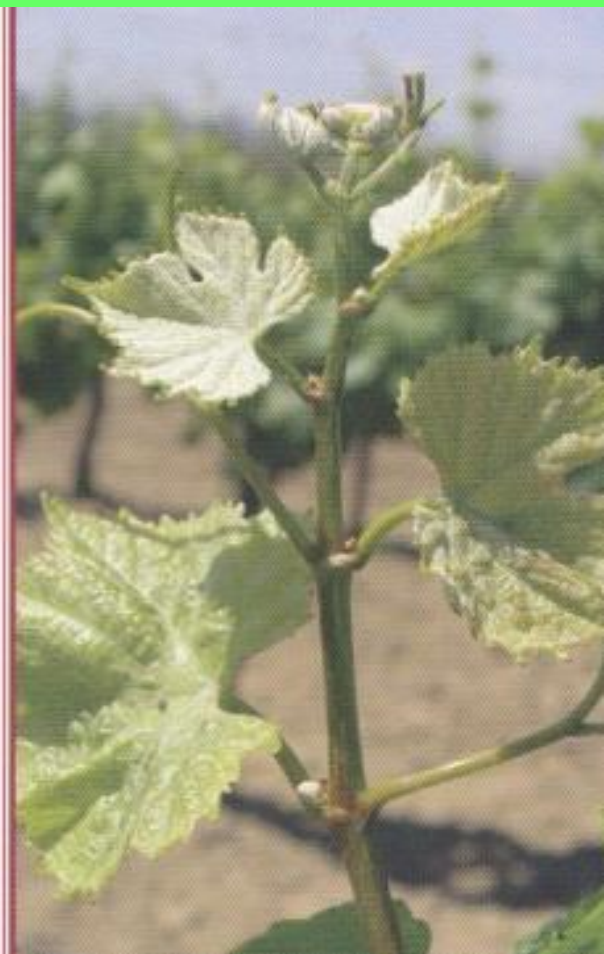
- Buds have a soft velvet coating
- Bottom side of the leaf: Arachnoid hairs
- Leaf margins roll outward
- Clusters are large to very large and compact
- Berries are round, rarely oval, small to medium-sized, juicy
- Varieties are commonly white or red

- Small seeds
- Seedless varieties are very rare
- Highly productive shoots
- Shorter growing season and high frost-resistance
- Most varieties grown for wine production
- Higher acid and sugar content (18-20 %), many varieties are partially (some of them fully) seedless
- Gamay, Traminer, burgundy varieties, Cabernet Sauvignon, Merlot, Semillon, Carignan, Malbec

Pinot Blanc



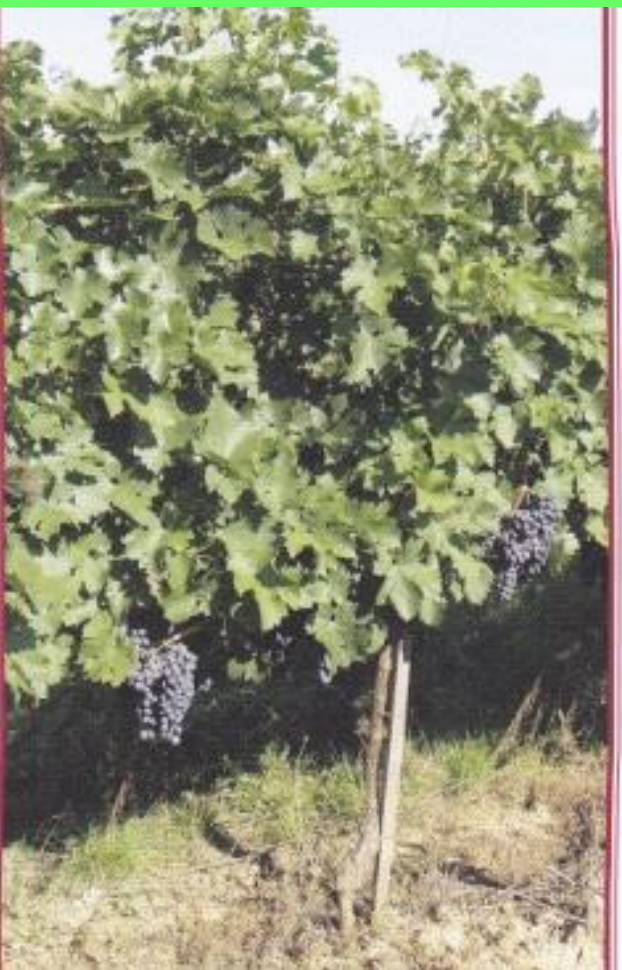


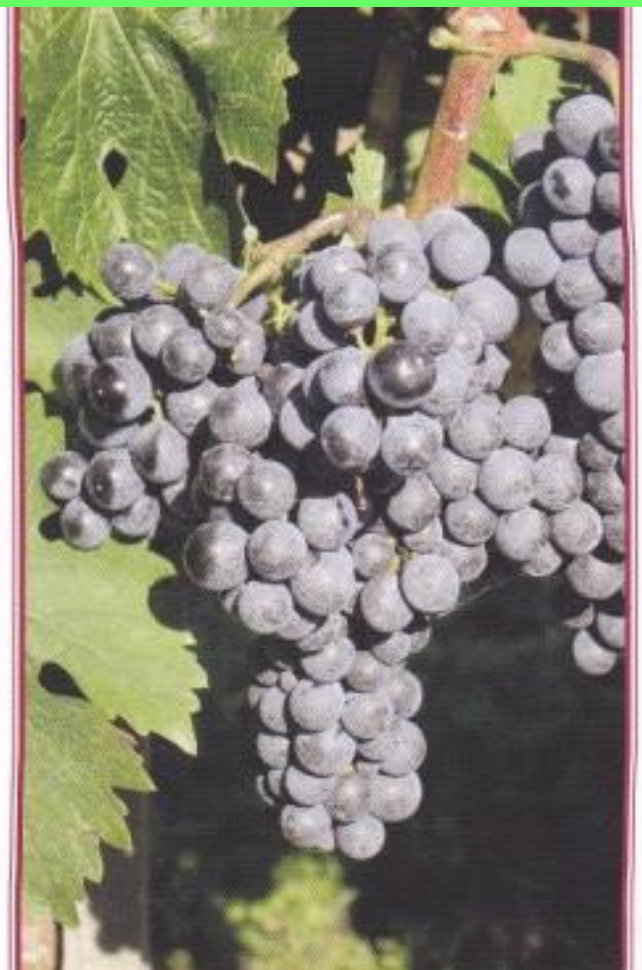


Pinot Gris

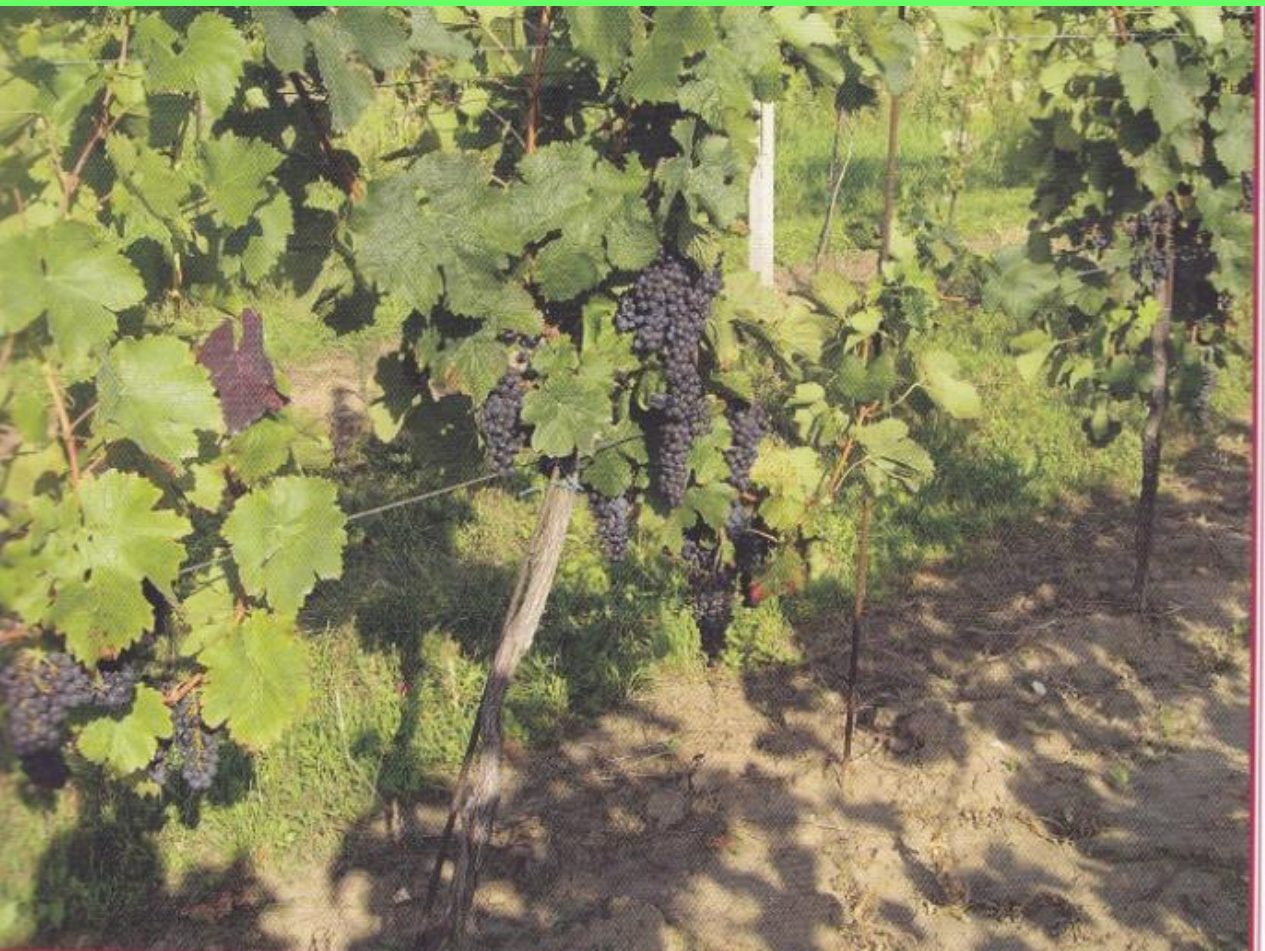
Pinot Noir

Cabernet Sauvignon





Merlot



Semillon

Characteristics of Proles orientalis

- Smooth, glabrous and shiny buds
- Bottom side of the leaf is smooth and glabrous, becomes setulose later
- Leaf margins are rolled inward
- Large, open, branched clusters
- Oval, ovoid or elongate, medium-sized to large, fleshy fruits
- Mostly white varieties; 30 % rose
- Medium-sized to large seeds

- Many varieties are partially seedless, some of them fully
- Low shoot productiveness
- Long growing season, very low frost-resistance
- Most varieties are table grapes, few varieties are good for wine production
- Grapes have low acidity and sugar content (18-20 %)
- Terbaš, Tavkveri, Muskat bělij, Chasselas, Tajfi, Nimrang, Katta, Kurgan, Kišmiš bělij

Chasselas Blanc

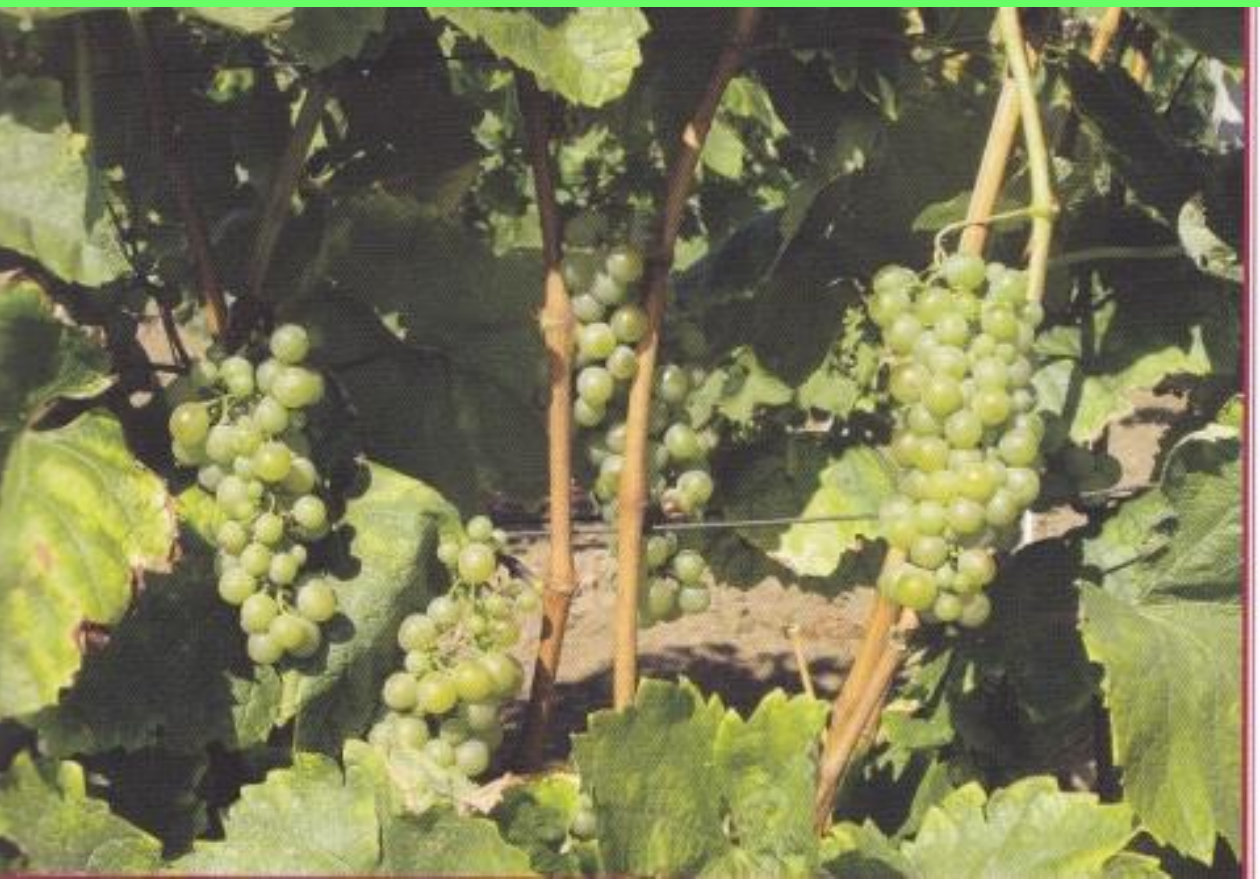
Characteristics of Proles pontica

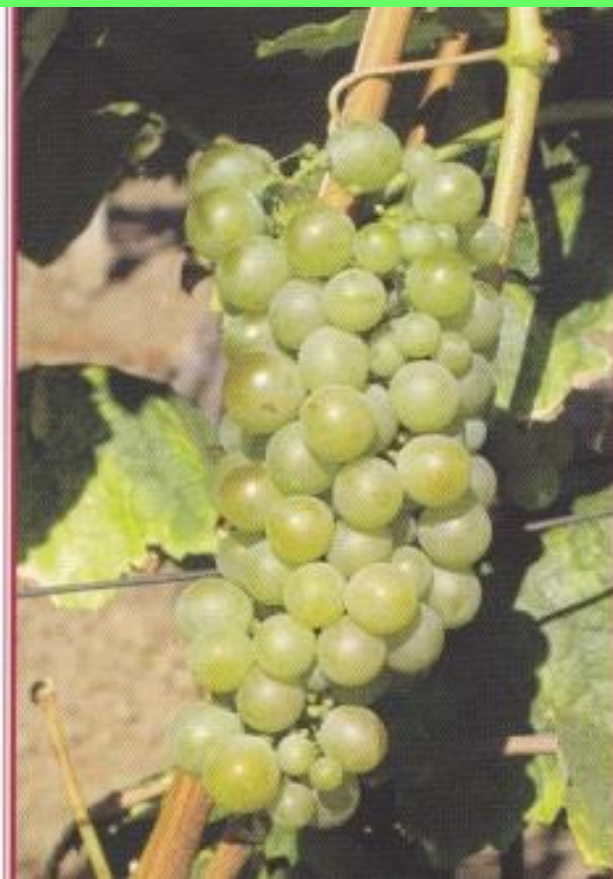
- Velvety, ash-grey to white buds
- Bottom side of the leaf is downy with arachnoid to setulose hairs
- Leaf margins are curved in various directions
- Medium-sized, compact, scarcely open clusters
- Round, medium to small, juicy berries
- Similar amount of white, rose and red varieties

- Small, medium and large (table varieties) seeds
- Many varieties are partially seedless, some of them fully
- High shoot productiveness
- Relatively frost-resistant
- Good for wine production and direct consumption
- Higher acidity and sugar content (18-20 %)
- Rkaciteli, Saperavi, Mcvane, Puchljakovskij, Korintka bílá
- Volské oko, Furmint, Lipovina, Banacký ryzlink, Kadarka, Ezerjo, Plavac

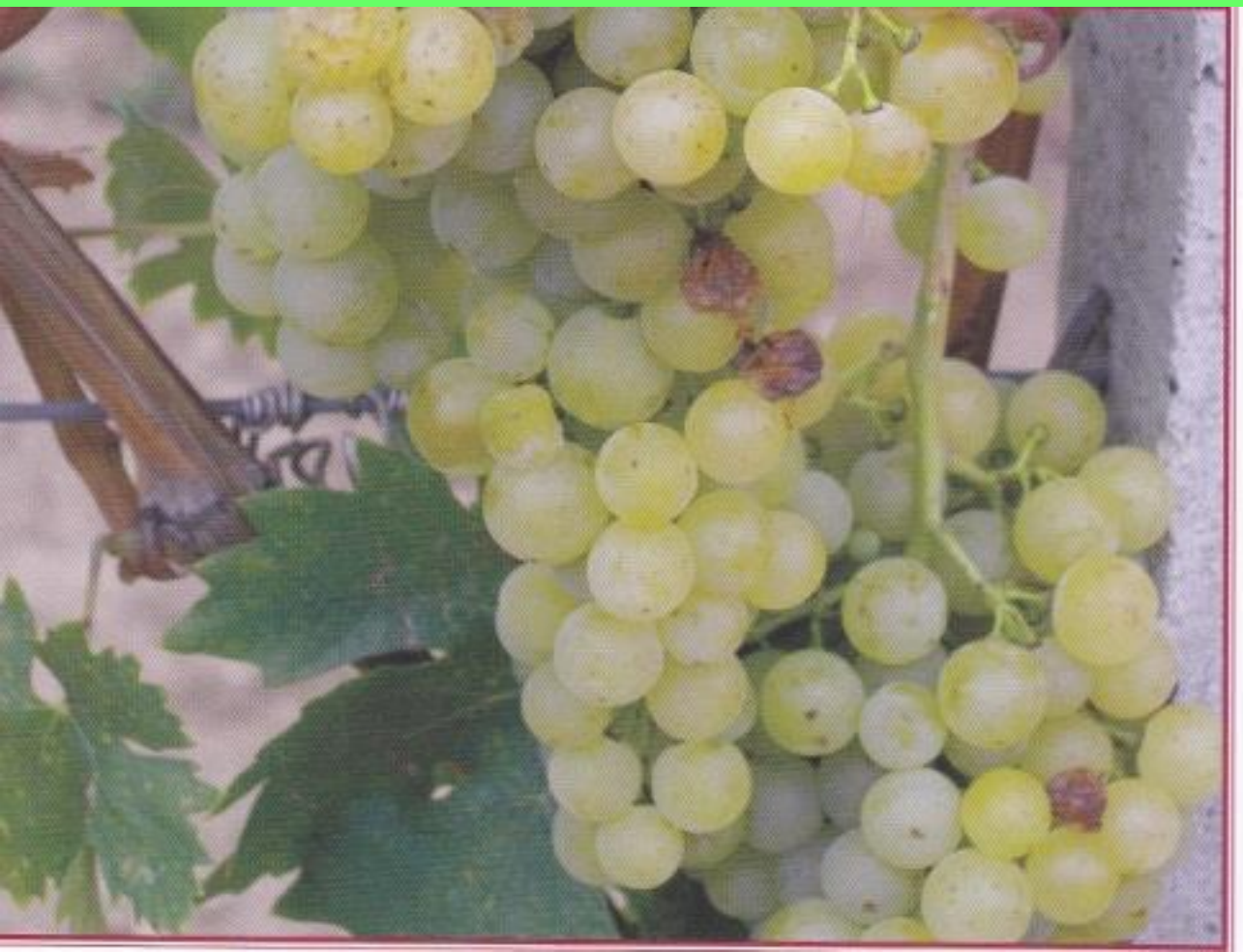
- Selecting suitable parental varieties for successful crossing of grapevine must stem from identification of environmental-geographic groups of the grapevine varieties

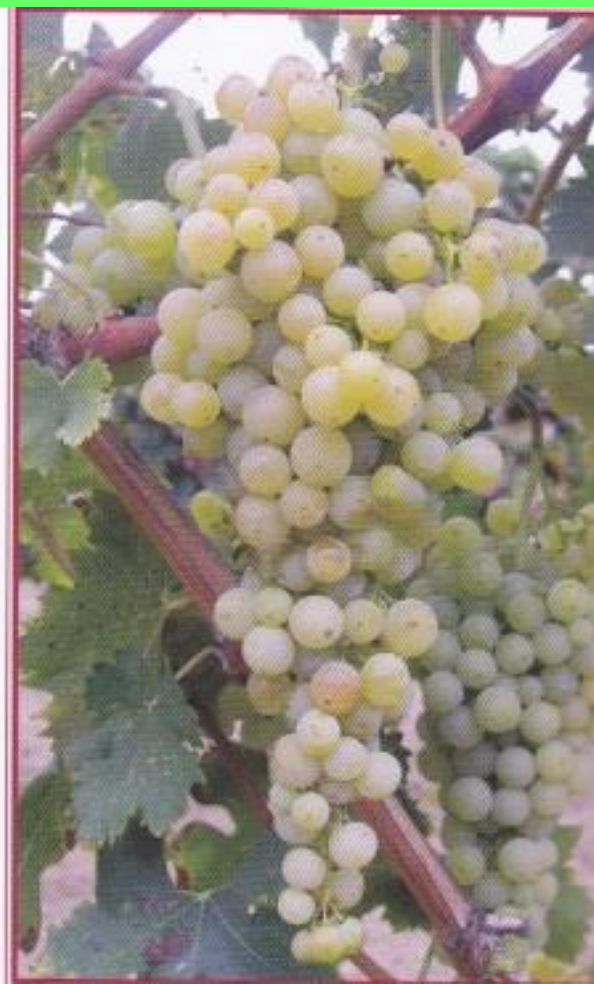
Furmint





Lipovina





LIFE PROCESSES, GROWTH AND DEVELOPMENT

Life cycle depends on:

Hereditary characteristics of the varieties

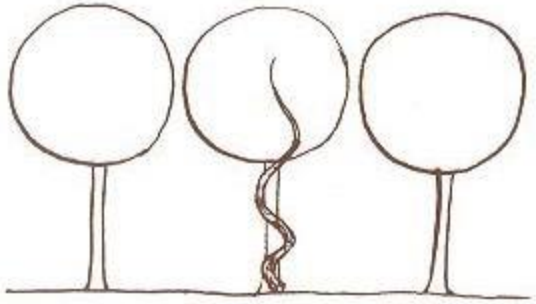
Pruning and training

Conditions at the vine location

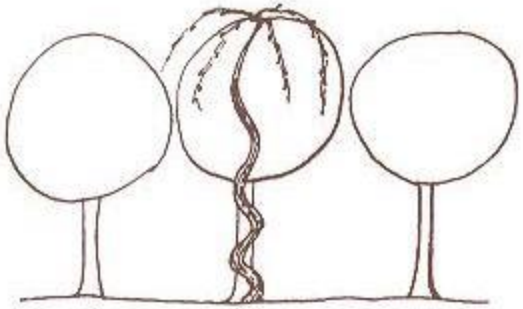
Cropping practices

The whole life cycle starts with cultivation of individual plant – the seedling and terminates with death of the vine. Vine goes through the stages of growth, development and physiological aging. Vines in Czech conditions usually live up to 25-30 years, rarely longer.

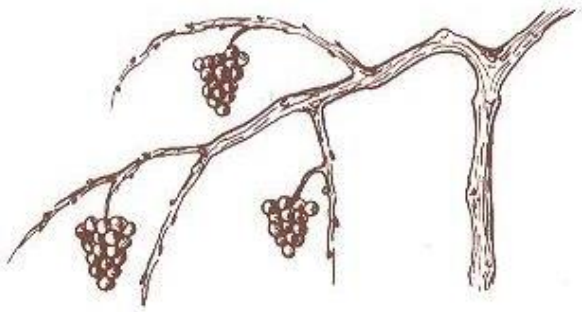
Způsob růstu révy vinné ve volné přírodě



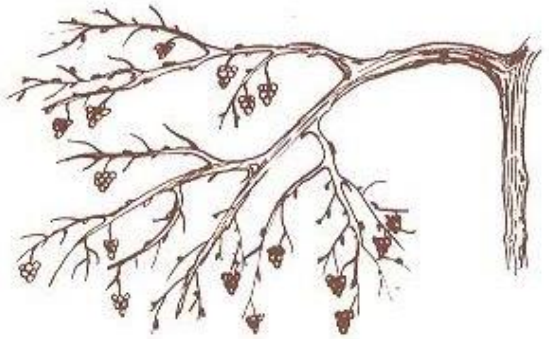
V podmínkách vyšší vlhkosti a nízké světelné intenzity lesa probíhá prolongační růstová fáze bez plodnosti.



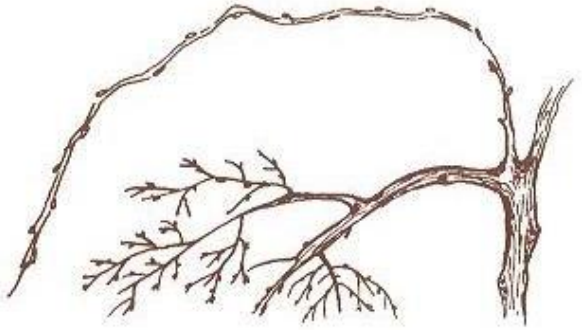
Když dosáhnou letorosty révy nejvyšších vrcholků stromů, změní se jejich poloha a zvýšená intenzita světla, to vyvolá tvorbu květenství na visících letorostech.



Při první plodnosti se vyvíjejí na málo rozvětvených větvích hrozny v menším počtu, ale o velké průměrné hmotnosti s vyšším obsahem cukrů.



Původní růstové patro se neustálým rozvětvováním silně zahustí. Narůstají jen krátké letorosty a velký počet malých hroznů s nízkým obsahem cukrů



Na stařině vyroste ze spícího očka bujný a dlouhý letorost, z něhož vznikne patro nové, výhodněji položené

Life cycle may be divided into 3 stages

First stage starts with seed germination or planting of a seedling (max. four years after planting). Formation of assimilation system for successful future development.

Second stage starts with an onset of productiveness and lasts until the first signs of aging. Most productive years: 10-20. The productiveness stage depends on cropping practices, training systems, proper nutrition, protection against diseases and pests, etc.

- Aging: Decrease in viability, productiveness, and biological processes, termination of growth. Aging causes: Soil fatigue, inadequate microbial processes, development of necrosis in vascular tissues (between root system and above-ground green plant parts)

ANNUAL GROWTH CYCLE

- Growing season is followed by dormancy.
- Growing season starts with a phenophase of the so called vine bleeding and bud break in spring, and terminates with ripening of fruits and wood in autumn.
- (Relative) dormancy starts with ripening of fruits and wood, and terminates with a phenophase of bleeding and bud break.
- Dormancy under the conditions of Czech climate usually lasts from Nov till March (120-160 days). Decrease in temperature during winter causes termination of life processes or their serious inhibition (relative dormancy).

Growth phenophases

- Vine bleeding and bud break
- Elongation growth
- Flowering and berry growth

Ripening phenophase

- Ripening of fruits and wood

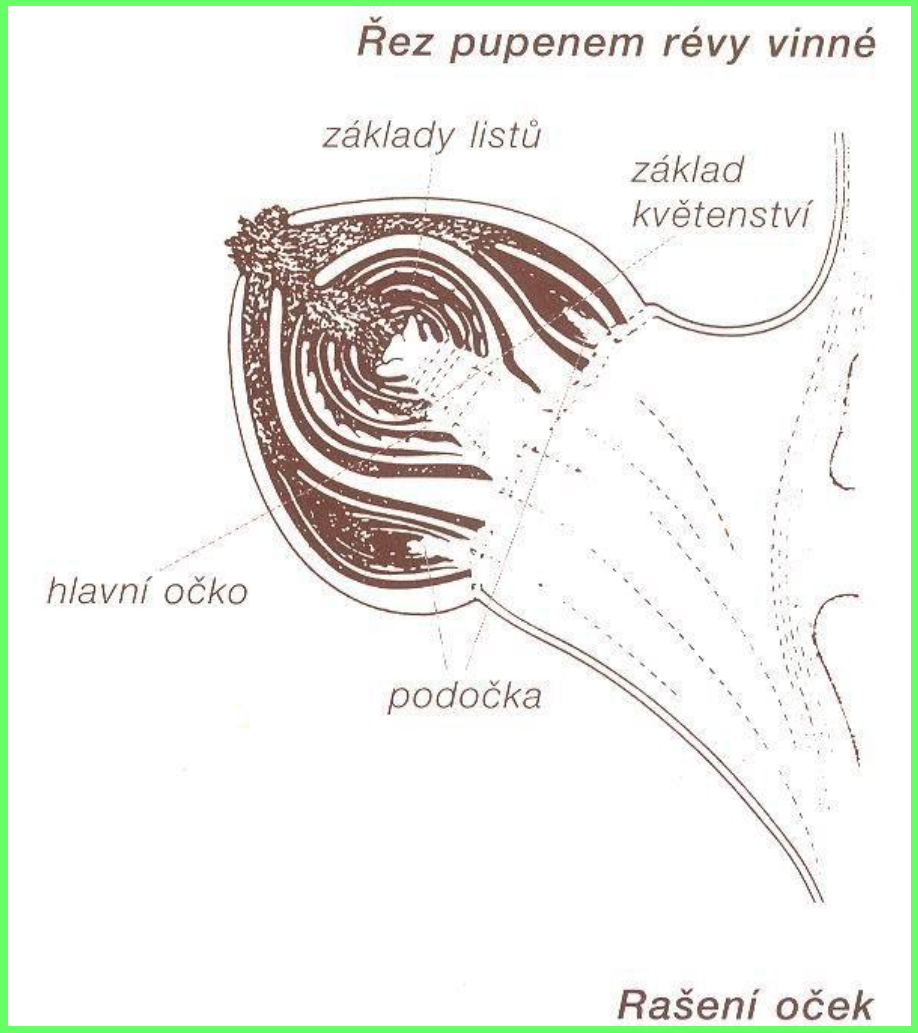
Dormancy phenophase

- Dormancy of winter buds

Bleeding and bud break

- Fresh cutting wounds, especially those close to the roots, bleed
- Lymph slowly concentrates; bacteria and fungi cause production of mucilage which closes vascular bundles (1 vine may bleed 0.1-5.0 L of lymph)
- First, water is pouring out; later, amount of dry matter rises (0.4 %). Content: 75 % organic substances, minerals (K, Ca) and phytohormones
- Soil temperature rise to 5-6 °C: First biochemical changes in the vine roots, followed by growth of root hairs (lymph starts to bleed)

- Amount of breaking buds is affected by environment; 20-50 % of all buds break on pruned vines. A bud consists of a primary bud and secondary and tertiary buds. Only primary buds break in spring
- First, shortened axis inside the bud starts to grow and subsequent differentiation occurs with sufficient amount of water and nutrients (N in soil); then, buds break and shoots start to grow
- Too many buds result in small panicles


Řez pupenem révy vinné
základy listů
základ
květenství
hlavní očko
podočka
Rašení oček

Elongation growth

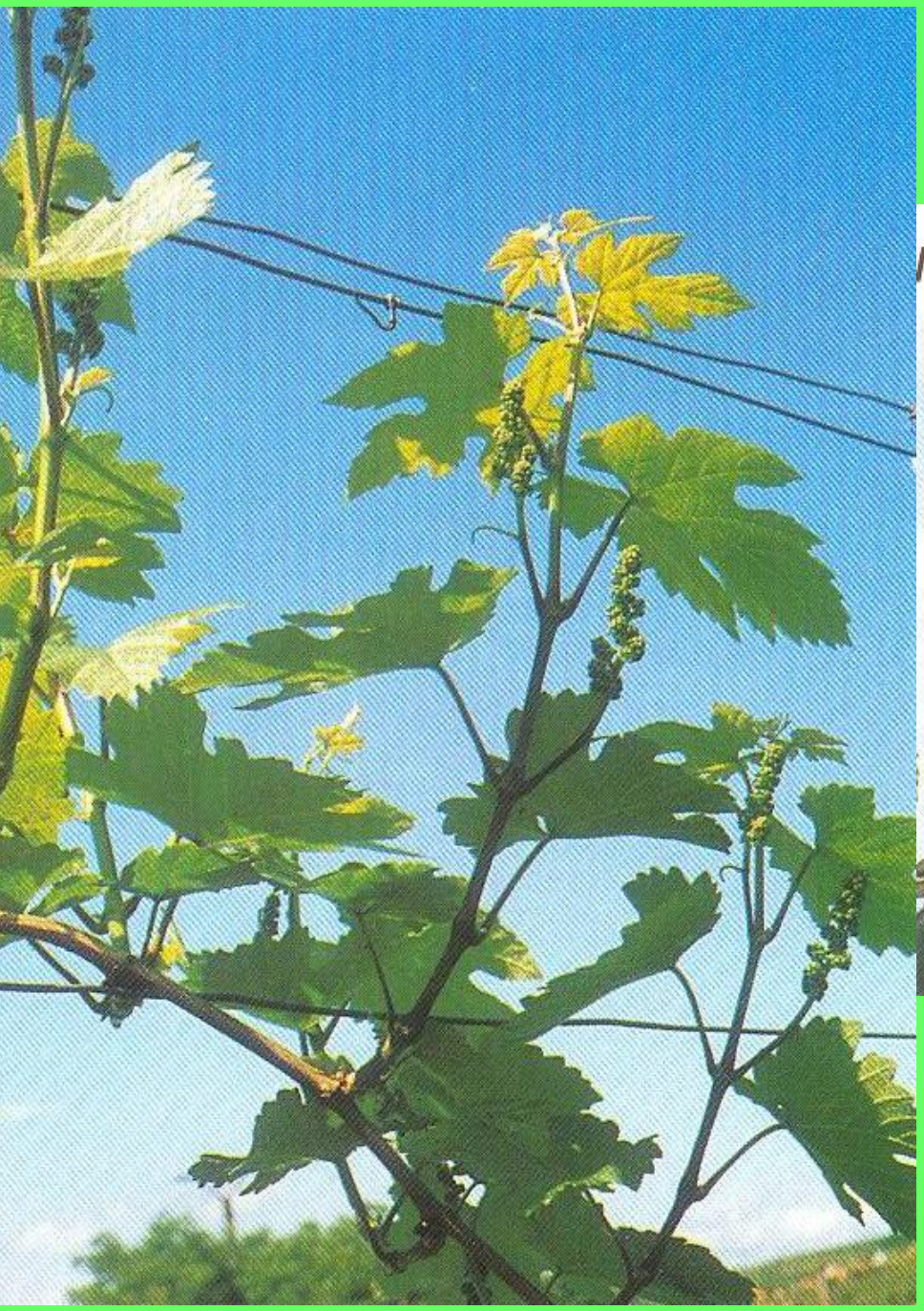
- First, shoot growth is slow as it takes energy from reserves stored in the root system.
- After temperatures rise, shoot growth accelerates and assimilates start to flow away from newly developed leaves.
- Leaf growth is also slow; most rapid shoot growth – shoot has 5-7 leaves (counting from the base)
- Before the flowering phase, shoot has 7-8 leaves with more than half the size of a regular leaf; after blossom loss, shoot has 10-12 leaves of a regular size. Photosynthesis intensity differs according to varieties.

- High intensity per leaf surface: Traminer, Zweigeltrebe, Rhine Riesling.
- During the major berry growth, clusters and roots are supplied with assimilation products from roughly 10 leaves; during verasion phase, clusters and roots are supplied from 13 leaves; and during berry ripening phase from 17 leaves.
- Leaves growing on bottom two thirds of the shoot are significant for berry development (cluster weight); leaves on the top third affect crop quality.

Transpiration

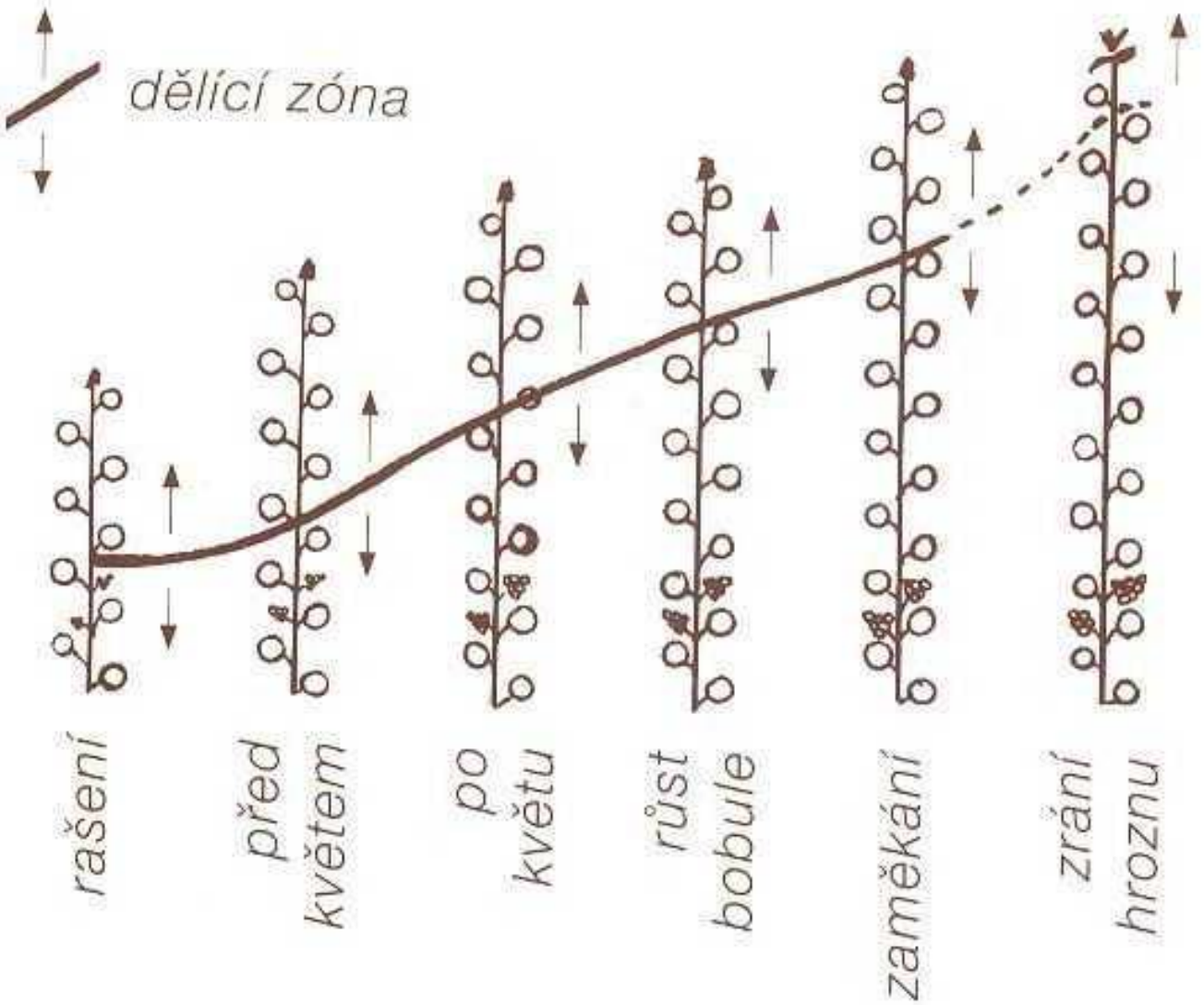
- Depends on site location and variety. Thick foliage causes higher transpiration in Traminer, Müller Thurgau, Limberger, Portugal, Welschriesling.
- Low transpiration in Rhine Riesling and Green Veltliner.
- Lateral shoots start to grow before and especially after flowering. Their anatomy and morphology is similar to regular shoots. Lateral shoots have higher assimilation intensity, transpiration and respiration than primary leaves.

- Lateral shoots growing on the bottom parts of the shoots are eliminated as they thicken the foliage around grape clusters, and become old and little productive during the ripening phase.
- Lateral shoots are topped, i.e. reduced, beyond the third to fourth leaf in vine upper parts to utilize assimilates products and transport them to the grape clusters (increase in sugar content).
- Pruning helps us control the crop as well as amount of foliage area, light perception and proportions of foliage and crop. Vines must be adequately loaded with fruiting buds (6-12 buds per m2 of vineyard).



Narůstání letorostů

Směr pohybu asimilátů během vegetačního období

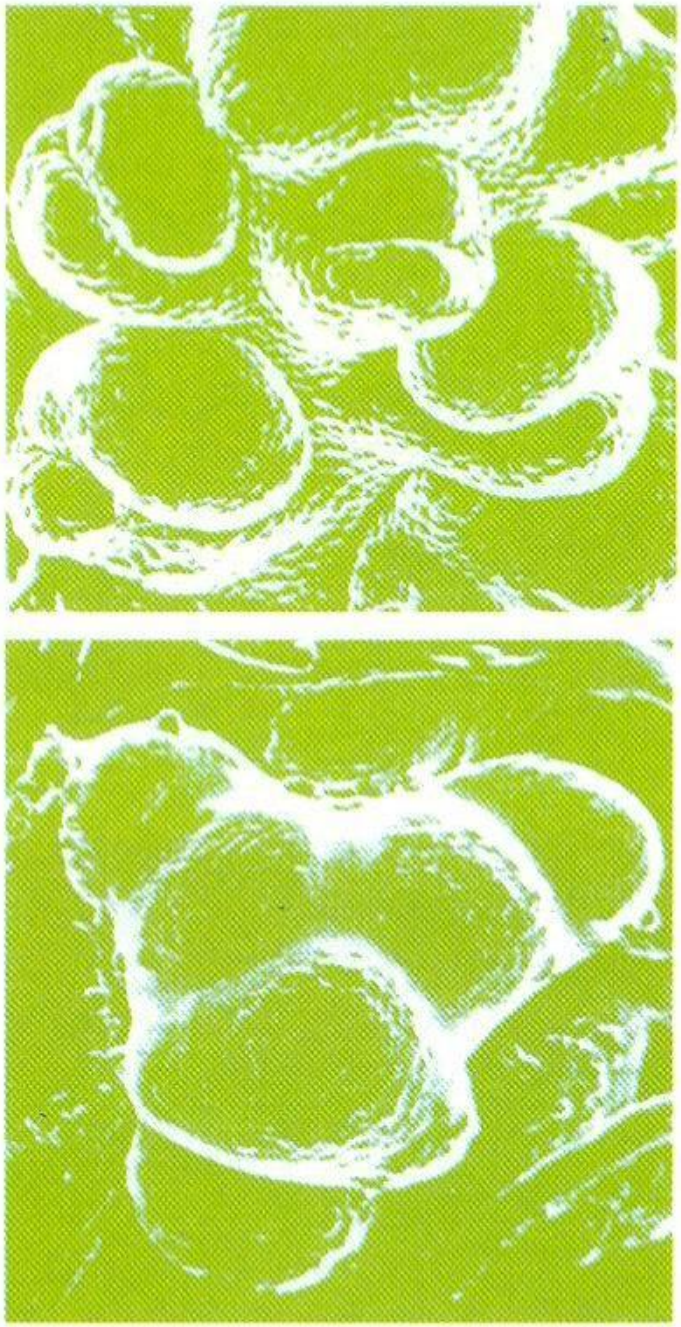


Flowering and berry growth

- A short phase of a growing cycle, high requirements on stable and warm weather (first 20 days in June).
- After buds start to develop inflorescences, individual parts of the inflorescence are established (until mid-Aug).
- Buds are activated at the end of winter and at the beginning of spring, and enter an enforced dormancy stage.
- Prolonged bud break and low temperatures favour differentiation to growth of shoots, and consequently large clusters are developed.

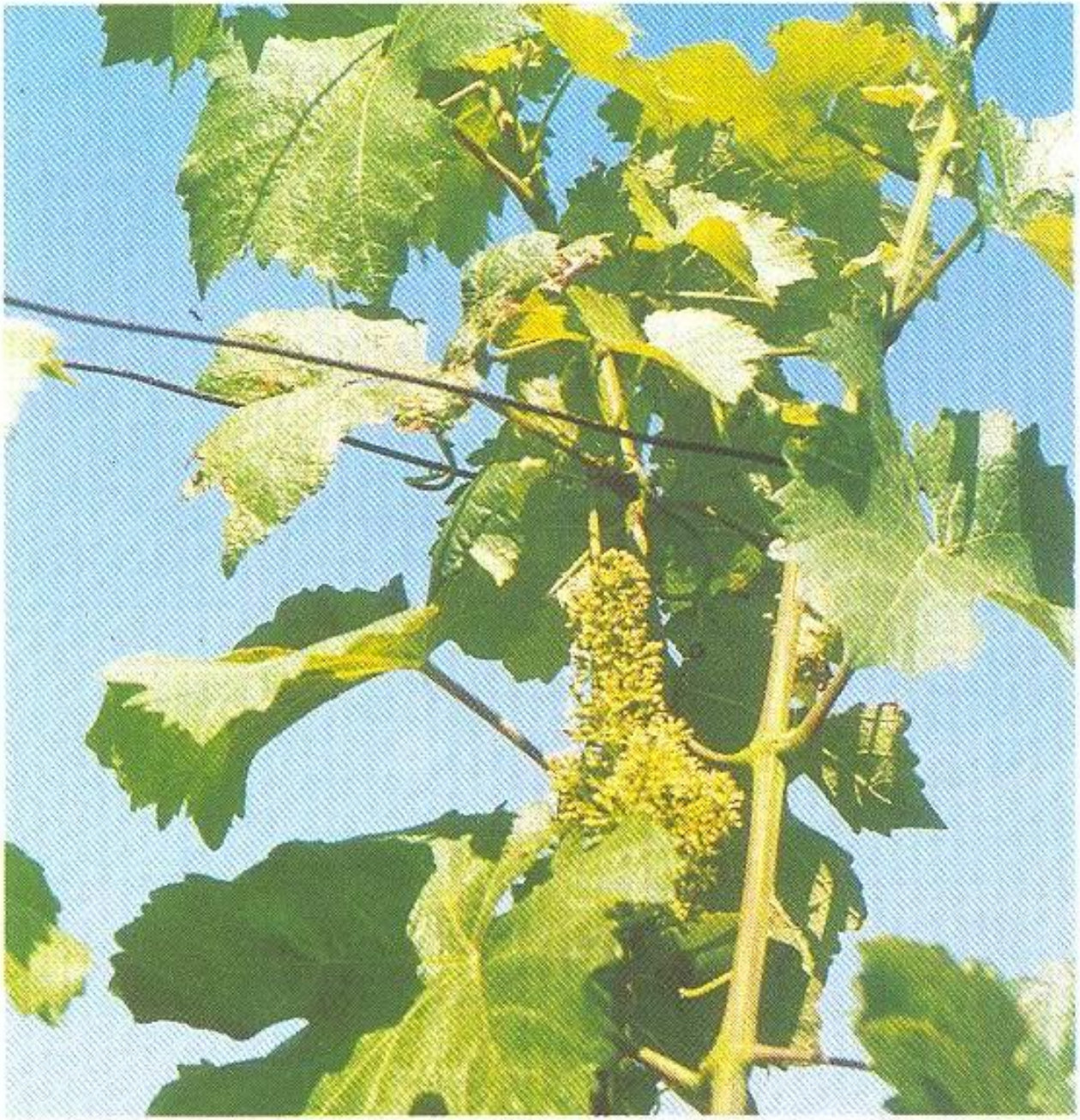
- Flowering requires favourable weather, flowers bloom especially in morning hours (8-11 AM).
- The higher the temperature and the drier the air, the more likely the anthers are to open; rain and high air humidity impede the process.
- Optimum germination and growth of a pollen tube: 25-30 °C.
- After an egg is fertilized in an ovary, fruit set begins – ovary is enlarged; transformation into grape berries.

Tvorba základů květenství



Kvetení

Opylování



- Tipping of shoot tops increases auxin levels (elimination of auxin “consumers”)
- Amount of auxins in flowers is increased, which improves fruit set
- Fruit set may have a complicated progress in certain varieties; some or even all of the flowers may fall off – the so called blossom drop.

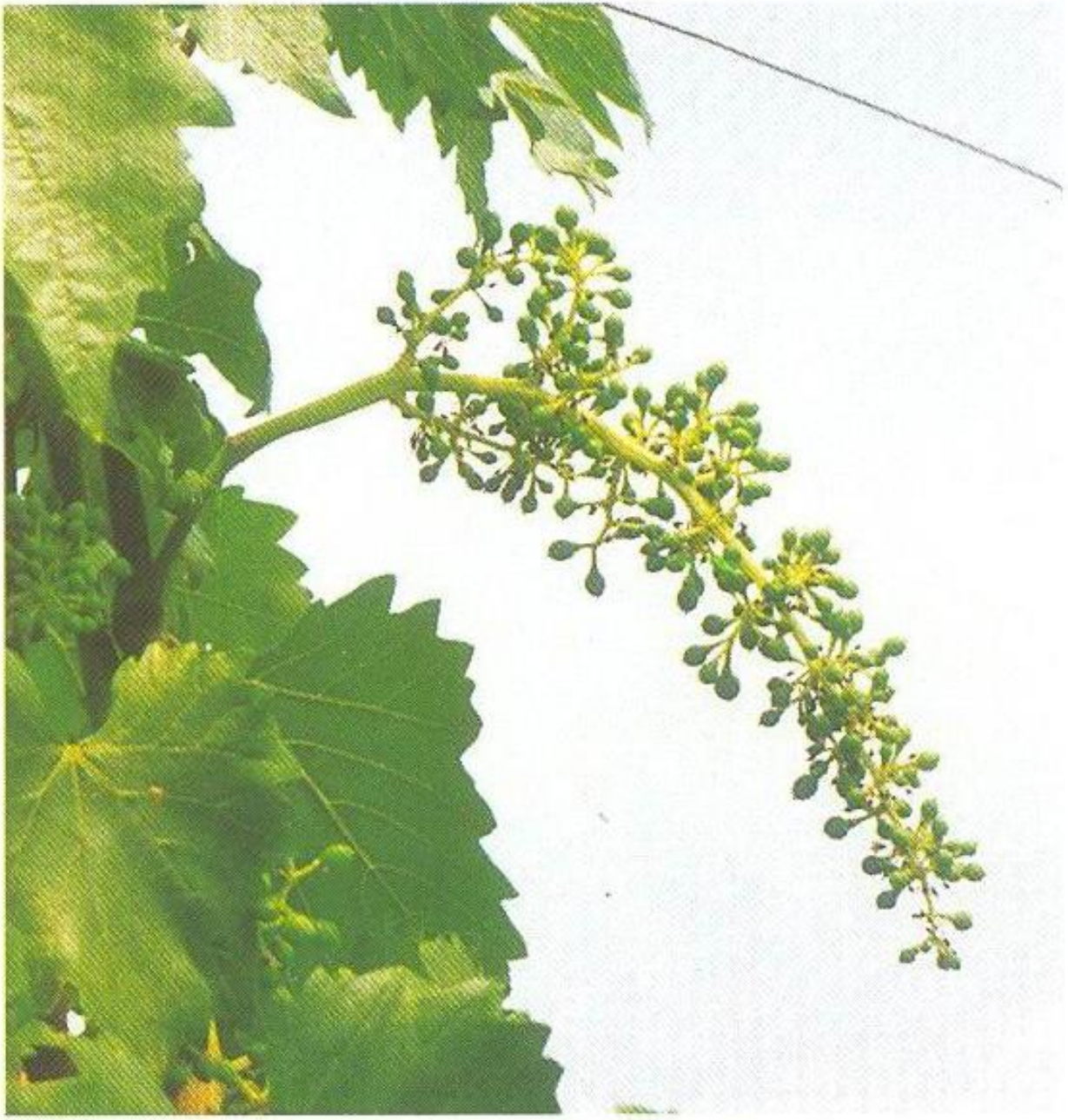
- Blossom drop causes: Unfavourable weather – cold, rain; grapevine leaf roll virus, chlorosis, grey mould, excessive N fertilization, unsuitable rootstock, a poorly bred variety, clone, herbicides (2,4 D) and microelement deficiency (B, Zn, Mo)

After fruit set, berries start to grow.

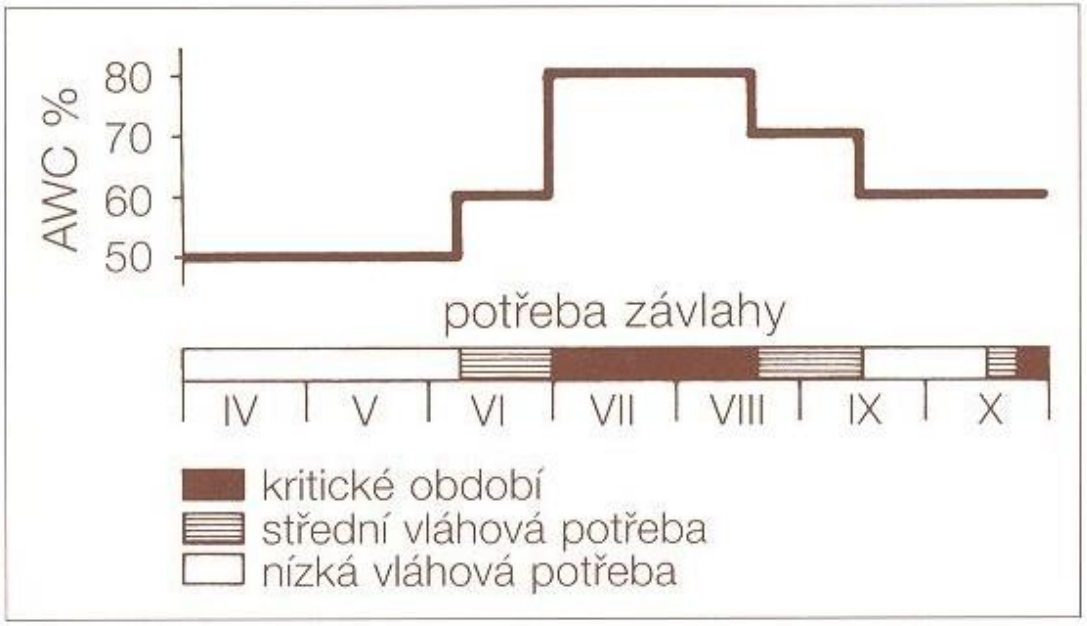
3 growth stages:

- Rapid seed vessel enlargement (3-5 weeks), berries get bigger quickly, number of cells in berries increases (more cell layers).
- Embryo, endosperm, and seeds coatings develop; seed vessel does not get larger; berry size remains the same; processes inside the berry continue
- Seed vessel becomes larger, berries swell (expansion of cells developed in the first stage; process continues until verasion phase when the berries reach their final size).

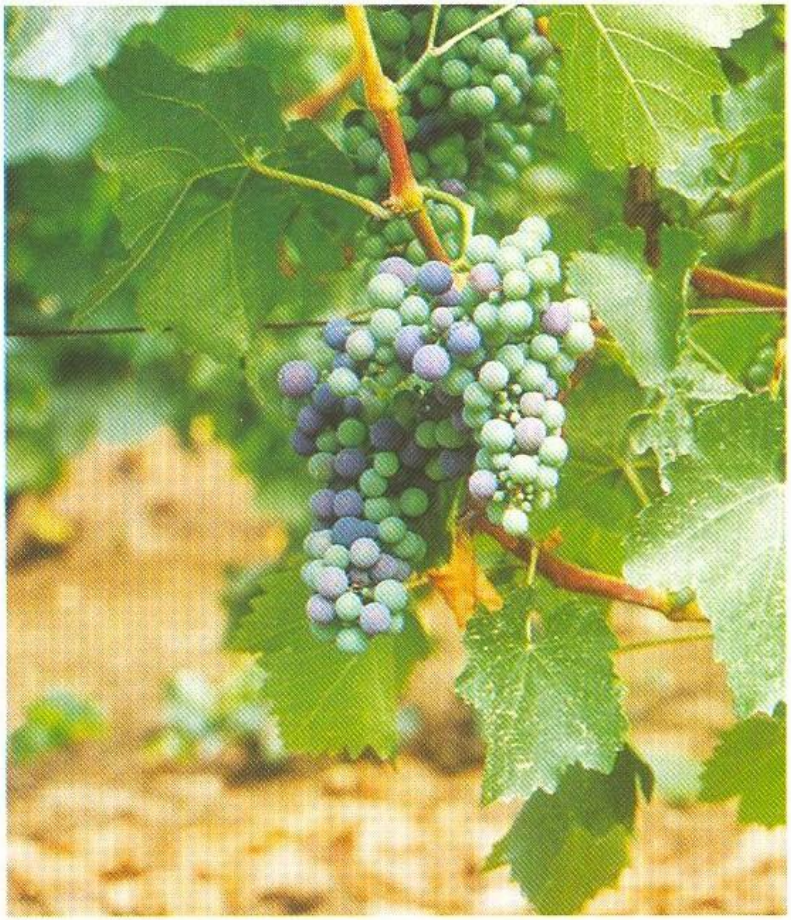
Nasazování bobulí



Náročnost révy na vodu během vegetace



Nalévání bobulí



RIPENING OF FRUITS AND WOOD

- Berries get bigger only by expansion of cells of the seed vessel.
- Surface of the berry: A layer of thick-walled cells covered with a thick waxed coating on the outside (protection against Oidium Uncinula necator, Botryotinia fuckeliana)
- Berries contain a large portion of chlorophyll (plus intensive assimilation and transpiration as in leaves) until they enter the verasion phase.

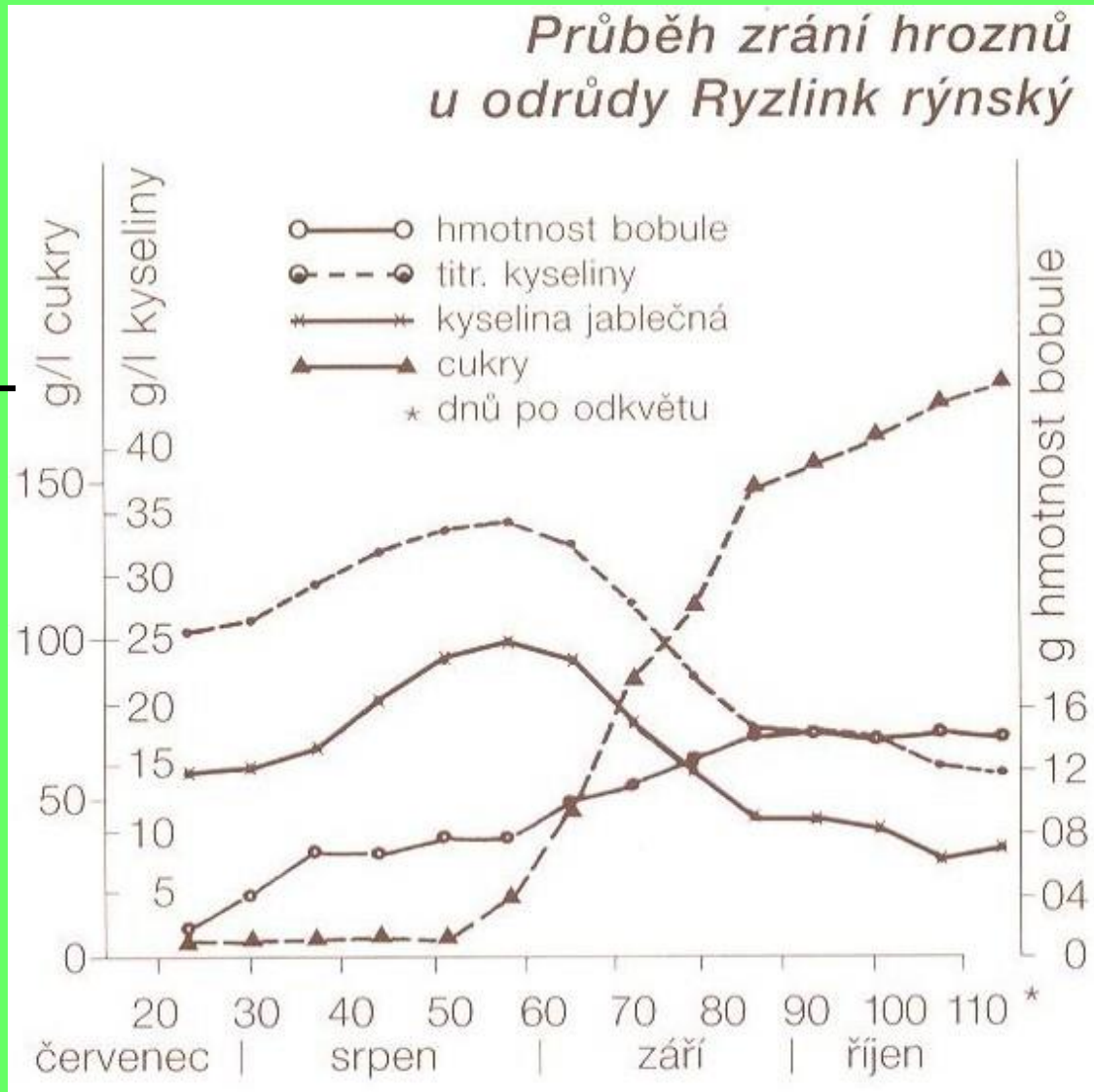
- After verasion phase, sugar storage follows complicated yet important principles. Increased amount of assimilates in the form of sugar concentrates in berries.
- Distribution of assimilates is largely affected by amount of berries per vine, i.e. crop size.
- Sugar content is constantly identical in all cluster and berries; berries past blooming ripen earlier and this may be used for a multi-stage harvest (most ripe berries are harvested first, others are left to ripen).

- Acid content: Highest amounts of malic acid and tartaric acid
- Temperature has a decisive impact on acid content in leaves during ripening of grapes
- Elimination of malic acid entering the berries from leaves is promoted by warming of the berries and light intensity. Water in soil also affects the elimination (moist soils increase acid content, especially malic acid concentrations).

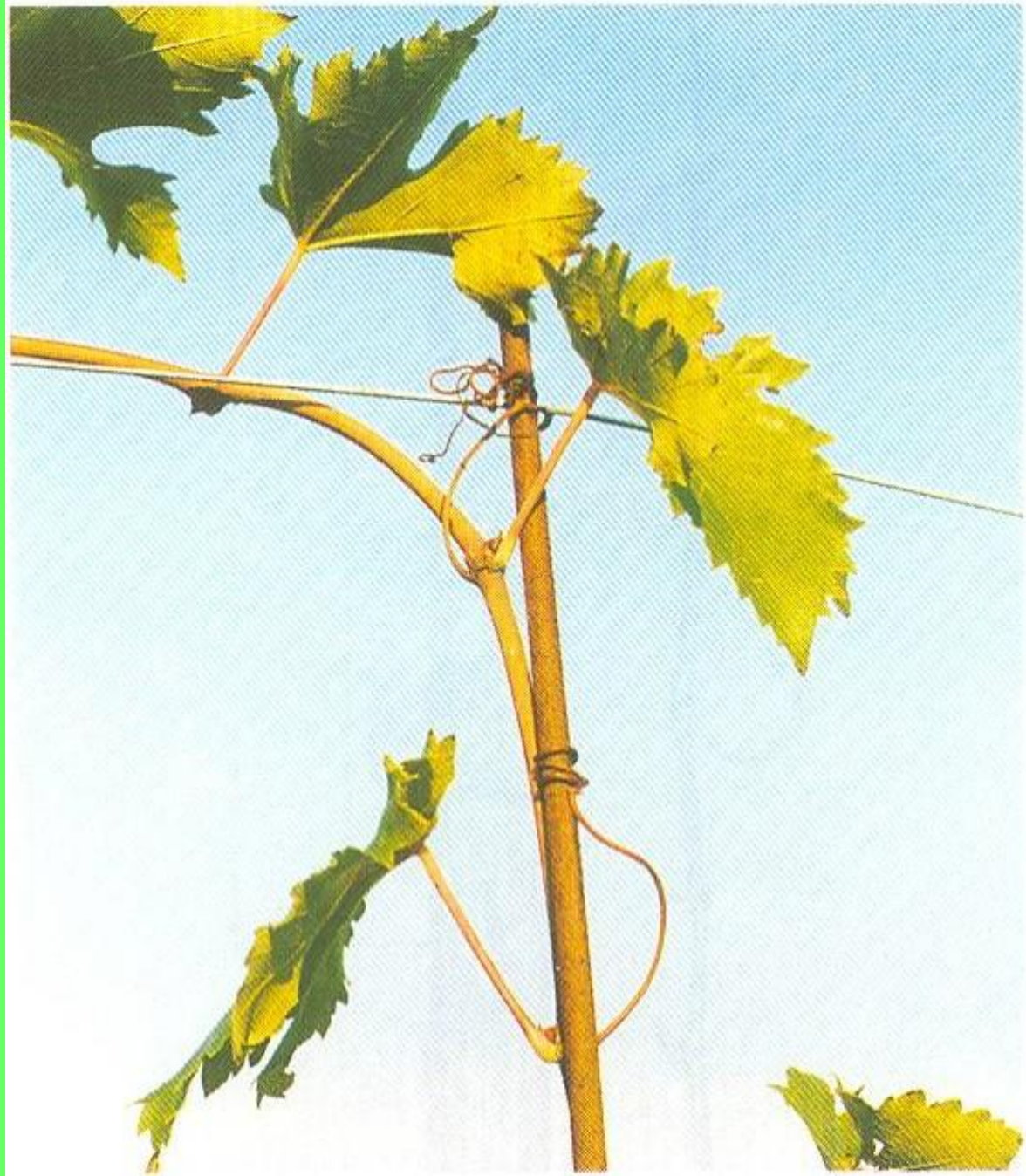
- Ripening of green shoots and their transformation into vine shoots is a process of anatomic and physiological reconstruction.
- Phellogen is formed from cells of the secondary phloem in the shoots. Phellogen produces cork towards the shoot centre (suberoderm) and phelloderm towards the shoot outer layers.
- All three layers (suberoderm, phellogen, and phelloderm) are known as periderm.

Phloem containing sieve tubes and phloem fibres is produced under the periderm.

Things to notice when assessing ripening canes - colour of the bark, and bundles of phloem.



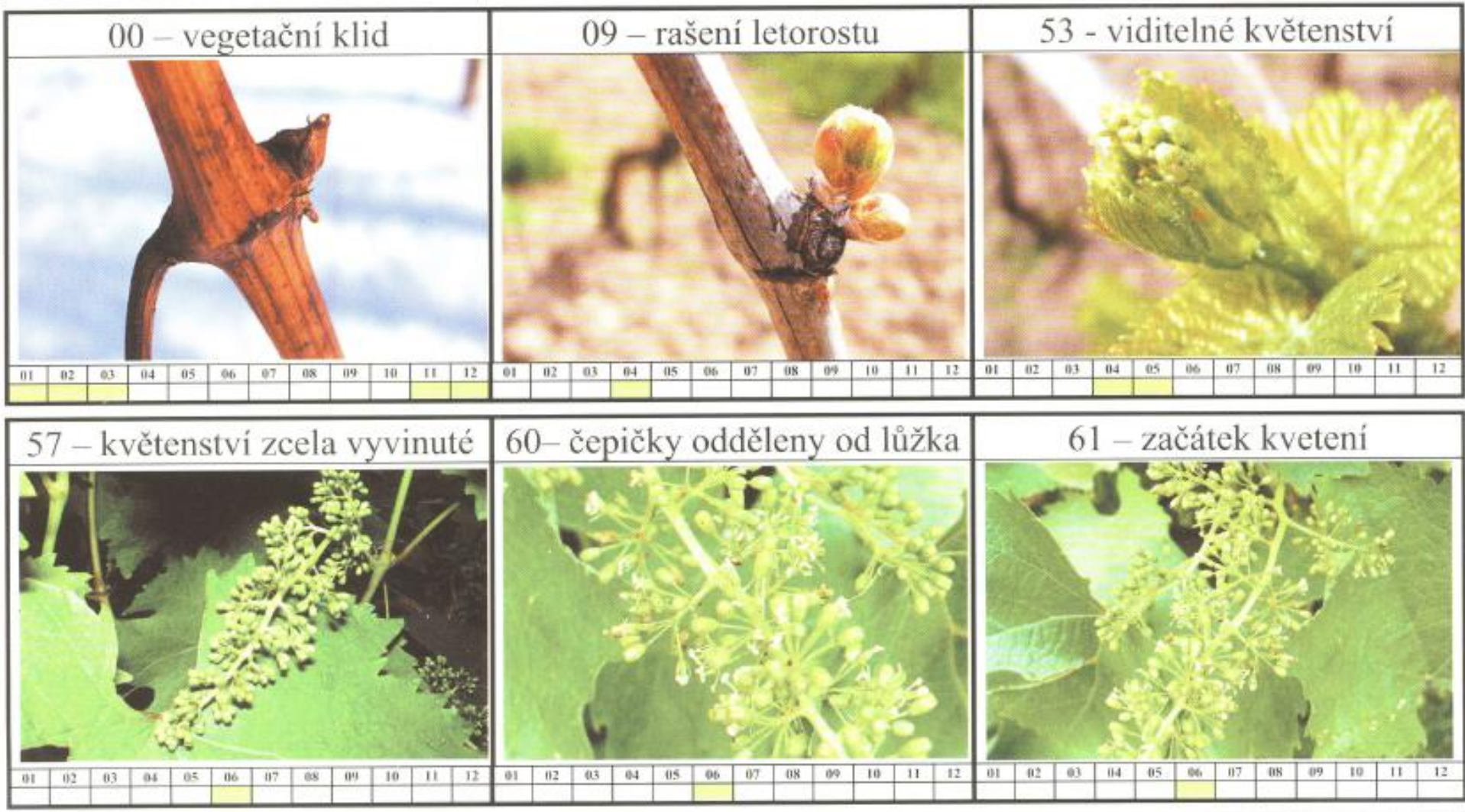
Vyzrávání letorostů



- Dormant buds and dormancy
- Dormant buds start to undergo complicated biochemical changes in mid-August; abscisic acid concentrations in buds increase, buds enter endogenous dormancy (until the end of Sep), and then the stage of post-dormancy (enforced dormancy).

- Buds adaptation to low temperatures affects their resistance to winter frosts.
- Short growing seasons require varieties with early cane maturing (Rhine Riesling, Pinot Blanc, and Pinot noir).
- Varietal resistance must be supported by proper cropping practices, training systems, nutrition and adequate fertilization with N and other important microelements.

Grapevine phenophases



Grapevine phenophases

- First attempts to classify phenophases of grapevine were conducted by an Italian botanist Baggioloni in 1952; in 1977, German scientists Eichhorn and Lorenz divided grapevine growing cycle into 24 stages using a 2-digit code system
- Hack et al. (1992) introduced a phenological development scale called BBCH in 1992; the scale aimed to improve plant protection against pests and diseases.
- Phenological development stages are divided into macro-stages and micro-stages (00 – 99).

The phenological growth stages and BBCH-identification keys of grapes

BBCH code Description of the phenological stage

Macrostage 0 – Bud break

0 Dormancy: winter buds pointed to rounded, light or dark brown according to cultivar; bud scales more or less closed according to cultivar

1 Beginning of bud swelling: buds begin to expand inside the bud scales

3 End of bud swelling: buds swollen, but not green

5 “Wool stage”: brown wool clearly visible

7 Beginning of bud burst: green shoot tips just visible

9 Bud burst: green shoot tips clearly visible

Macro stage 1 Leaf development – amount of unfolded leaves

11 First leaf unfolded and spread away from shoot

12 2 leaves unfolded

13 3 leaves unfolded

14 4 leaves unfolded

15 5 leaves unfolded

16 6 leaves unfolded

19 9 and more leaves unfolded

Macro stage 5 Inflorescence development

53 Inflorescences clearly visible

55 Inflorescences swelling, flowers closely pressed together

57 Inflorescences fully developed; flowers separating

Macro stage 6 Flowering

60 First caps detached from the receptacle

61 Beginning of flowering: 10% of caps detached

62 20% of caps detached

63 Beginning of flowering: 30 % of caps detached

64 40 % of caps detached

65 Full flowering: 50 % of caps detached

66 60 % of caps detached

67 70 % of caps detached

68 80 % of caps detached

69 End of flowering

Macro stage 7 Development of fruits

71 Fruit set: young fruits begin to swell, remains of flowers lost, ovaries expand

73 Great-sized berries, clusters begin to hang down

75 Pea-sized berries, clusters hang down

77 Berries in clusters begin to touch

79 Majority of berries touching

Macro stage 8 Ripening of fruits

81 Beginning of ripening: berries begin to develop variety-specific colour

83 Berries develop colour

85 Verasion

89 Berries ripe for harvest

Macro stage 9 Onset of dormancy

91 After harvest; end of wood maturation

92 Beginning of leaf discolouration

93 Beginning of leaf-fall

95 50% of leaves fallen

97 End of leaf-fall

99 End of growing season

65 – plné kvetené

01	02	03	04	05	06	07	08	09	10	11	12

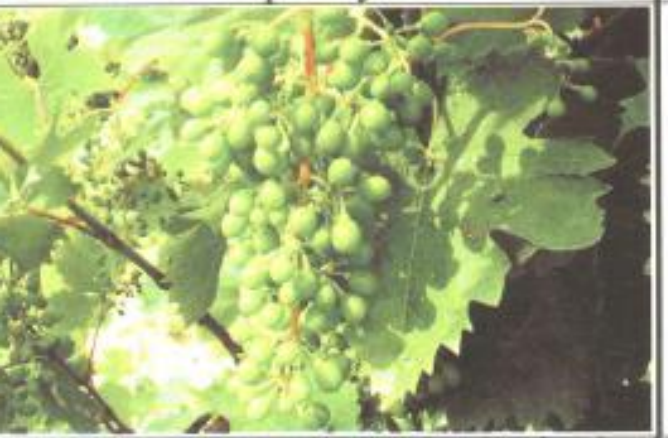
71 – začátek vývoje bobulí

01	02	03	04	05	06	07	08	09	10	11	12

73 – bobule velikosti broku

01	02	03	04	05	06	07	08	09	10	11	12

75 – plody visí



01	02	03	04	05	06	07	08	09	10	11	12

77 – začátek uzavírání hroznů

01	02	03	04	05	06	07	08	09	10	11	12

81 – začátek zrání

01	02	03	04	05	06	07	08	09	10

85 – měknutí bobulí

01	02	03	04	05	06	07	08	09	10	11	12

89 - konzumní zralost

01	02	03	04	05	06	07	08	09	10	11	12

92 – počátek zbarvování listů

01	02	03	04	05	06	07	08	09	10	11	12