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Tato prezentace je spolufinancovaná z Evropského sociálního fondu a státního rozpočtu České republiky

Growth and Development of Fruit Trees

- Fruit plants produced generatively (from seeds) must undergo a specific period of its development (juvenile phase)
- In juvenile phase: Smaller buds, intensive sprout branching, thorn development
- Vegetative propagation: Plants without a typical juvenile phase, specific period of infertility (shorter than in generatively propagated plants), basically without anatomic and morphological differences

Life-cycle Phases

- Initial phase (juvenile phase)
- Adult phase
- Full productiveness phase
- Aging phase

  - Initial phase, various anatomic and morphological particularities, various time duration, apple tree: 5-12, pear tree: 7-14, stone fruits: 3-6 years, berries: 2-5 years

- - Productiveness phase: Development of generative organs, genetically conditioned, length of the phase differs in various trees
- - Full productiveness phase, productiveness phase differs, slowly decreases and disappears
- - Aging phase, inevitable, may be reversed by rejuvenation (training, rootstock, cropping practices)
- - Age phases apply to all fruit species, prominence and speed depends on specific species and varieties, environmental conditions and cropping techniques
- - Pomaceous fruits age slower than stone fruits

- - Aging has more profound consequences in adverse conditions: plantings age more rapidly and die earlier
- - Appropriate cropping promotes a desired productiveness with adequate annual productivity growths during full productiveness phase

- Life phases of fruit trees
- - Two distinctive phases regularly alter during the year
- - ■ Growing season is followed by dormancy
- - ■ Length and course of the phases are genetically conditioned (reflect the adaptation to natural conditions)

- A phenological phase (phenophase) occur gradually in a predefined pattern:
- Growing season
  - Sprouting and blooming
  - Vegetative growth
  - Development and differentiation of flower buds
  - Fertilization
  - Growth and ripening of fruits
  - Ripening of tissues and accumulation of reserve substances
  - Leaf loss
- Dormancy

Phenophase of sprouting and blooming

- Starts with increase in bud size, and ends with blooming of adult plants
- Flower buds develop in several steps. First, buds increase in volume; second, panicles develop, blooms start to differentiate (a green flower-bud); third, rolled petals develop (a pink flower-bud)
- Flower is formed when 25 % of the blossoms break, termination - 75 % blossom loss
- Relative blooming time: Early, medium early, medium late and late blooming varieties
- Onset and length of phenophase depends on species, variety and complex of external factors

Vegetative growth

- Starts with development of annual shoots, ends with formation of terminal buds
- Annual shoots growth has 3 phases: Initial, strong and final phases
- Productive shoots stop growing first, long, vigorous shoots on the outside of the crown stop growing as last
- Termination of growing is accelerated by lack of nutrients, water, air in soil, pests and diseases infestation, excess amounts of fruits, etc.

Phenophase of development and differentiation of flower buds

- Starts with formation of flower buds and ends with formation of stamens and pistil
- Onset of development of flower buds depends on the phase of annual shoot growth termination
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- Formation of flower buds is affected by overall nutrition of the tree and its parts; flowers buds are formed on short cluster bases first and on longest growths as last
- Phenophase lasts 3-3.5 months in pomaceous fruits, and 2-2.5 months in stone fruits
- Proper cropping techniques stimulate formation and differentiation of more/fewer buds

Phenophase of fruit trees fertilization

- There are following types of fruit tree fertilization
- ■ Cross-fertilization (pollen of another tree and another variety is necessary for fertilization)
- ■ Autophily (autofertility): Pollination using the tree's own pollen – higher chances of pollination
- ■ Parthenocarpy: Production of fruit without fertilization, no embryo
- ■ Apomixis: Fruit production without fertilization, seed production
- Pollination is usually performed by insects, significant role: honey bee; bees pollinate 75% of flowers, wind pollination – anemophily (walnut, hazelnut)

Phenophase of fruits growth and ripening

- Starts with zygote creation and ends with seed ripening
- Fruits of pomaceous fruit grow evenly throughout the growing season
- Cells of stone fruits undergo intensive division in the first phase, size and weight of the fruit rapidly rises; only few cells divide in the second phase, stone grows; fruit pericarp rapidly increases in size in the third phase, its cells enlarge
- Biochemical processes change content of sugars, acids, tannin, and aromas
- Healthy, developed leaf is a guarantee of good fruit growth (lack of water and nitrogen compounds accelerates fruit ripening)

Phenophase of ripening of tissues and accumulation of reserve substances

- Growth intensity decreases at the end of growing season, hydrolysis dominates over synthesis
- Starch is partially hydrolysed, and gradually converts in soluble sugars, amount of soluble nitrogen compounds, fats, and tannin increases
- Young cells differentiate in permanent tissues, lignin stores in cell membranes, tissues lignify
- In contrast to declining vegetative growth of the aboveground parts, roots growth starts to accelerate and reaches its maximum before leaf loss
- Buds finish their growth before leaf loss; reserves substances (starch) accumulates in buds and neighbouring areas

- Chlorophyll decreases; amount of silicic acid, calcium carbonate, and calcium oxalate increases, chlorophyll fades, carotenoids remain present
- Leaves gradually fall, leaves inside the crown fall before leaves on the outside, leaves on the bottom of annual shoots fall before leaves on the top of the annual shoots
- Biochemical processes do not cease after leaf loss, some of them intensify; amount of nitrogen compounds, fats, tannin increases; lack of water increases the concentration

Phenophase of dormancy

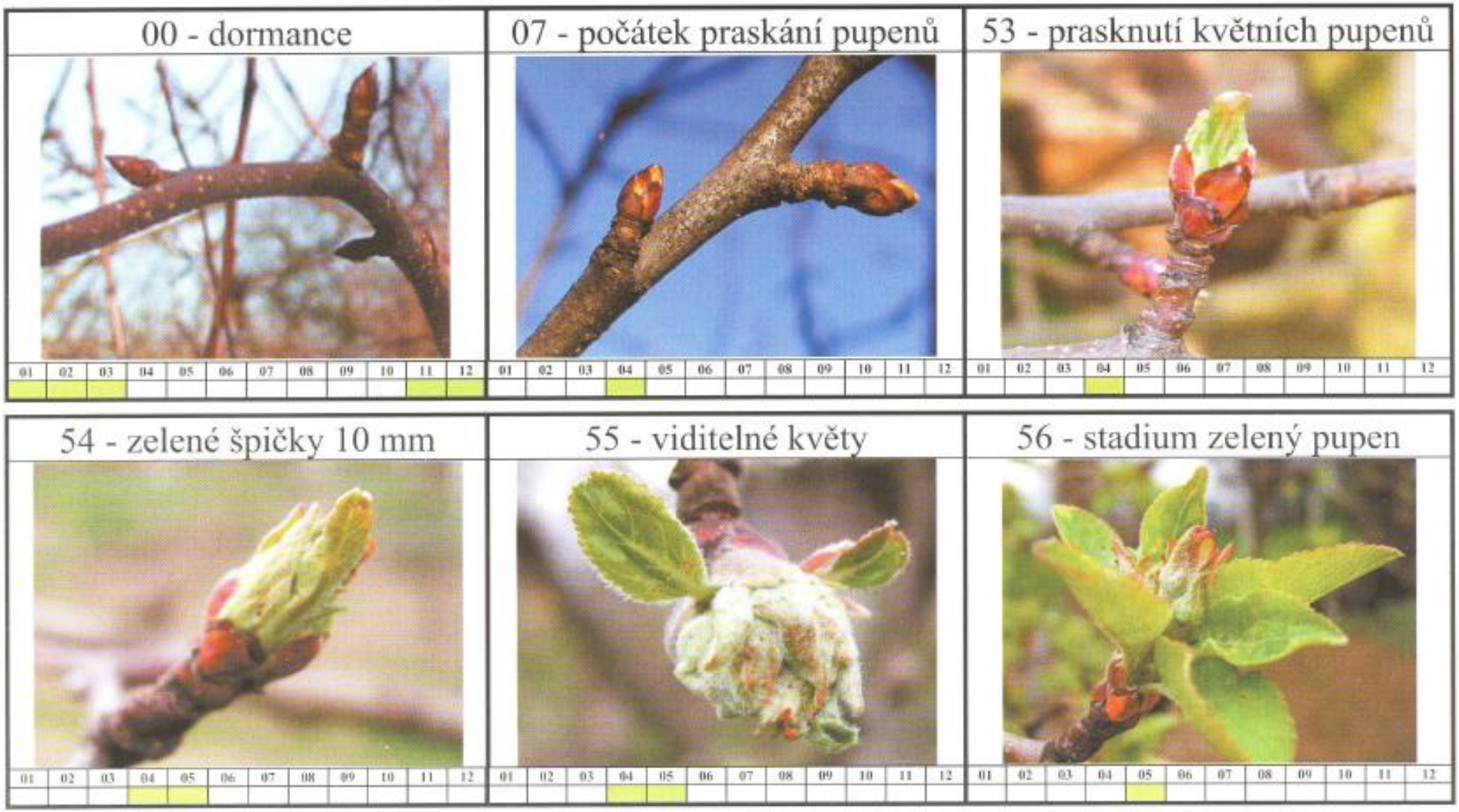
- Classification
- Dormancy
- Exogenous dormancy: Forced dormancy
- In Czech climate, dormancy lasts from Sep to Jan; deepest stage lasts from Oct to Nov
- After the dormancy is over, fruit trees remain in forced dormancy (low temperatures) until leaves start to sprout and flower buds develop

Pollination in fruit trees

Apple trees

- Cultivated varieties are heterogamous; apple trees may be autogamic as well as parthenocarpic
- Proper selection of pollinators must consider the blooming time, ripening, tree requirements on chemical protection and attractiveness for the bees
- Growing mutually pollinating varieties in blocks is the most common method of pollination (blocks of plantings are 10-60 m wide, depending on the variety and climate)
- Single-variety plantings: Source of pollen comes from pollinator plantings or pollinator graftings (3-8 % in a row)
- 2-4 bee colonies per 1 ha (beehive entrance is perpendicular to the tree lines, best if facing south or east)

Phenophases of apple trees



57 - stadium červený pupen

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

59 - korunní lístky tvoří balón

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

60 - první květy otevřené

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

65 - plný květ

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

71 - plod velikosti do 10 mm

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

74 - plody do 40 mm

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

81 - počátek zrání

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

87 - sklizňová 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

Pear tree

- Cultivated varieties are heterogamous, parthenocarpy is common
- Basically similar pollination rules as for apple trees, pears are less attractive for bees
- Blooming time and mutual pollination compatibility must be considered when selecting a proper pollination method (there are triploid hybrids – Lucasova)
- There should be more pollinators per plantings than in apple tree plantings (at least 3 bee colonies per 1 ha)

Phenophases of pear tree

00 – dormance

07 - počátek praskání pupenů

53 - prasknutí květních pupenů

54 - zelené špičky 10 mm

55 - viditelné květy

56 - stadium zelený pupen

57 - stadium červený pupen

59 - korunní lístky tvoří balón

60 - první květy otevřené

65 - plný květ

71 - plod velikosti do 10 mm

74 - plody do 40 mm

81 - počátek zrání

87 - sklizňová zralost

92 – počátek zbarvování listů

Cherry tree

- Cultivated varieties are heterogamous (except for Stella)
- Incompatibility is common (many of the most cultivated varieties)
- In addition to incompatibility, blooming time and requirements on chemical protection against cherry fruit fly must be considered; each variety should be in close vicinity to the pollinator, pollinators are planted alternately in every third row

Phenophases of cherry tree

00 – dormance

53 – praskání květních pupenů

55- viditelné květní pupeny

56 – prodlužování korun.lístků

57 - viditelné květy

59 – korunní lístky tvoří balón

60 – první květy otevřené

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

65 – plný květ

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

67 – vadnutí květů

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

72 - odumřelé kališní lístky

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

75 - plod velikosti do 50%

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

81 – počátek zbarvování plodů

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

87 – sklizňová zralost

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

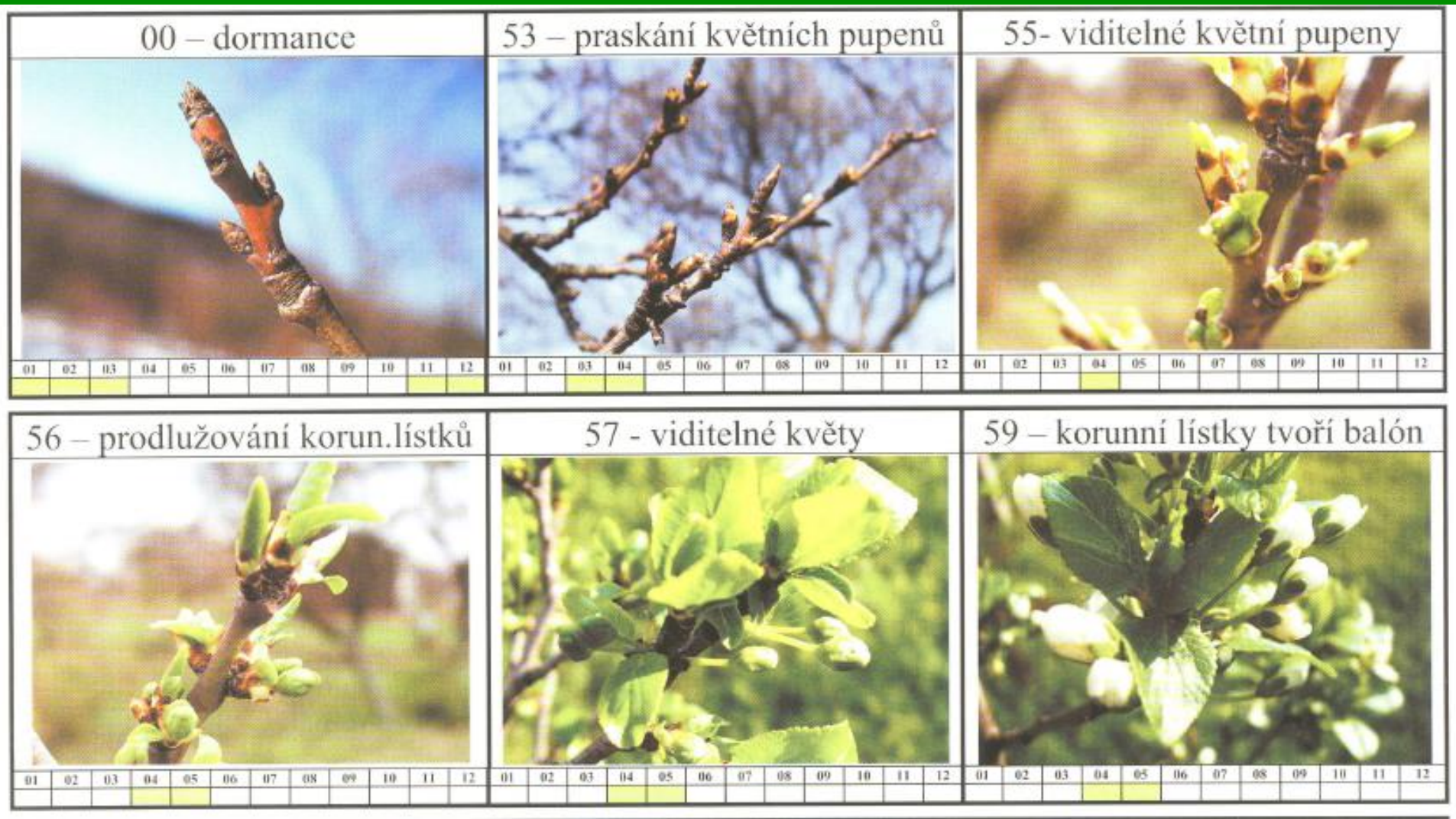
Sour cherry tree

- In addition to autogamic varieties (Morela pozdní, Fanal, Morellenfeuer), there are also heterogamous varieties
- Pollinators should be blooming in roughly similar period as the main variety; early blooming sour cherry varieties may be pollinated by late blooming cherry varieties
- Pollinators should be grown in rows (every third to fifth tree) in strip plantings
- 4 bee colonies per 1 ha

Plum tree

- In addition to autogamic plum varieties, there are also heterogamous and partially autogamic varieties
- Partially autogamic varieties and heterogamous varieties should be combined with varieties blooming at the same time
- Cross-pollination in block plantings (2- to 4-row blocks), mutually pollinating varieties or the pollinator is planted into the main variety block as a mixture (every third to fifth tree) in each row, with adjacent rows offset
- 3-4 bee colonies per 1 ha are required for pollination of heterogamous varieties

Phenophases of plum tree



60 – první květy otevřené

65 – plný květ

67 – vadnutí květů

72 - odumřelé kališní lístky

75 - plod velikosti do 50%

81 – počátek zbarvování plodů

87 – sklizňová zralost

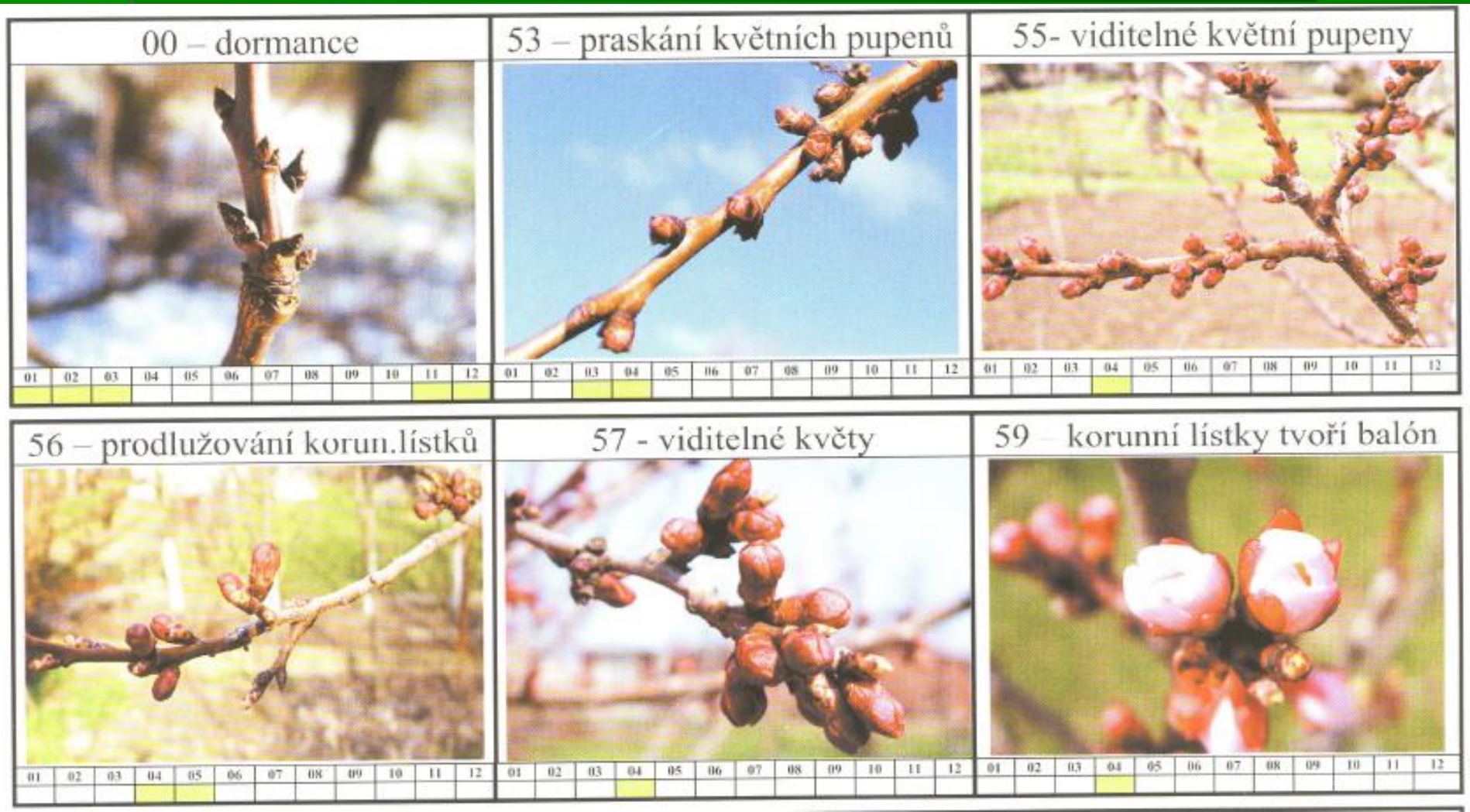
89 - konzumní zralost

92 – počátek zbarvování listů

Apricot tree

- Most of the varieties are autogamic; some of them are partially autogamic and produce better fruits in mixed variety plantings
- Bloom early, blooming period usually takes place in bad weather, bees are not strong enough, 3-4 bee colonies are thus necessary per 1 ha

Phenophases of apricot tree



60 – první květy otevřené

65 – plný květ

67 – vadnutí květů

72 - odumřelé kališní lístky

75 - plod velikosti do 50%

81 – počátek zbarvování plodů

87 – sklizňová zralost

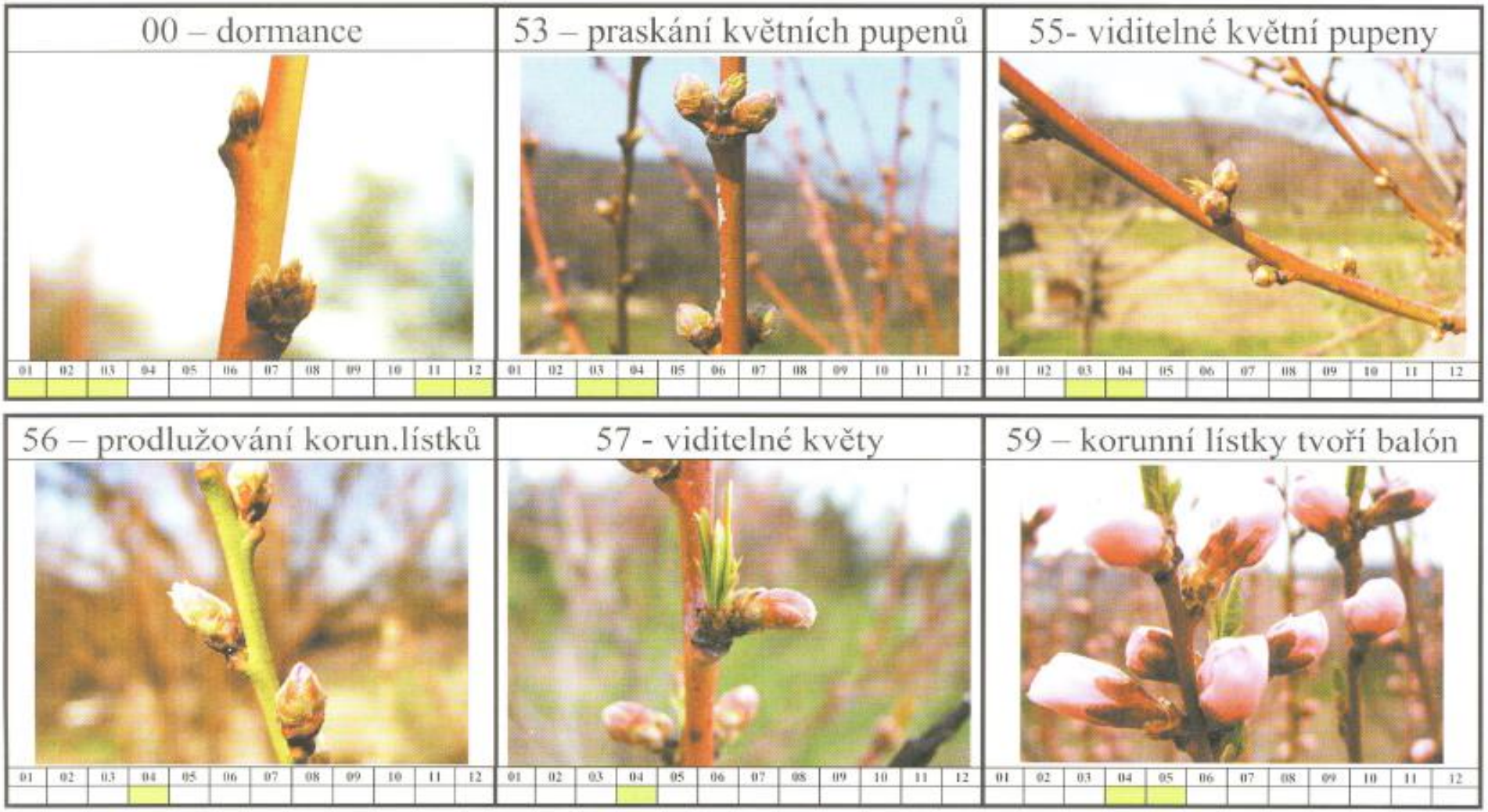
89 - konzumní zralost

92 – počátek zbarvování listů

Peach tree

- Most of the varieties are autogamic, bees are still necessary for proper pollination
- 1-2 bee colonies per 1 ha

Phenophases of peach tree



60 – první květy otevřené

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

65 – plný květ

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

67 – vadnutí květů

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

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Currant

- Red and white currants are autogamic, plant at least two varieties blooming at the same time
- Unripe black currant fruits often fall due to heterogamy
- Cross-pollination in autogamic varieties increases amount of fruit set as well as amount of seeds, fruit weight and total crop yield

Gooseberry

- Varieties are highly autogamic
- Plant at least two varieties

Raspberry, blackberry

- Diploid, autogamic, entomophilous varieties
- At least two varieties should be planted together during stands establishment (production of larger fruits and better crops)

Strawberry

- Varieties are androgynous and autogamic, no need for cross-pollination
- Bees and bumble-bees are necessary during poor weather