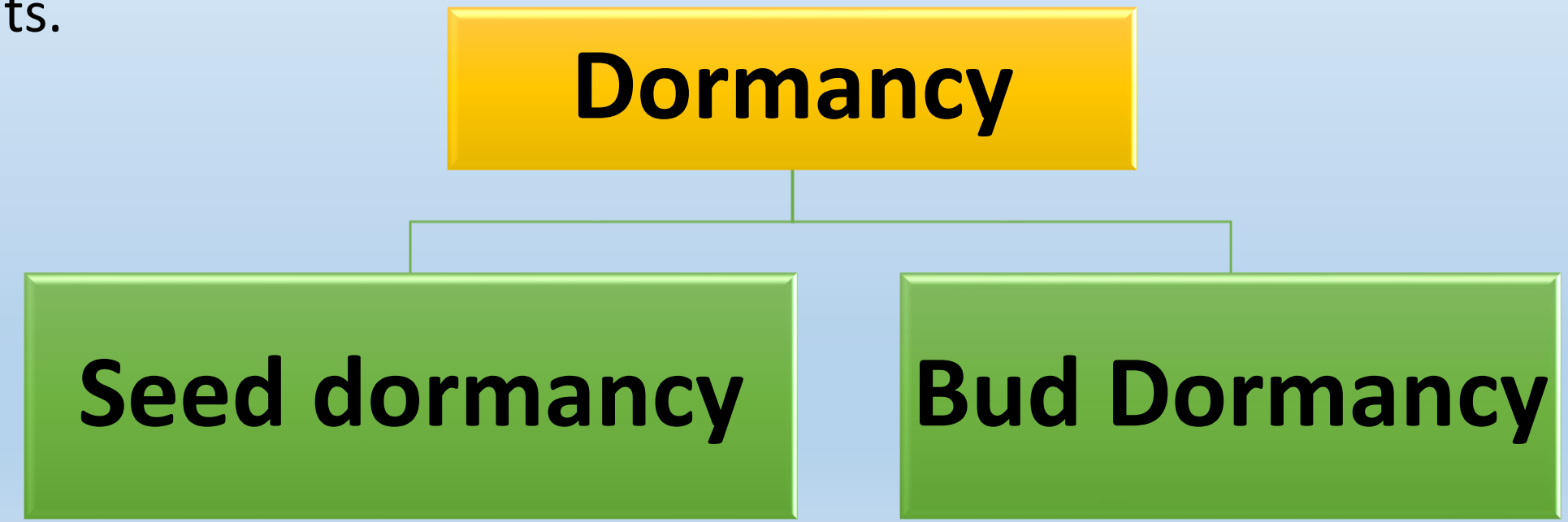
PHYSIOLOGY IN HORTICULTURAL PLANTS

DORMANCY

- Dormancy is to stop growing of buds or germination of seeds even if the plant or seed being at the optimum environmental conditions. It is possible to see the dormancy in seeds and in buds of horticultural plants.



Seed dormancy

- **Physical dormancy** may be caused by hard, non-permeable seed coats as in stone fruit species. This kind of seed coat provide a barrier to the entrance of water and in some plants, oxygen, as well.
- **Physiological dormancy (Endodormancy),** may be due to a number of mechanisms. These commonly involve growth – regulating systems of inhibitors or promotors. Inhibiting substances that block the germination process may be present in the flesh of the fruit, in the seed coat or even in the endosperm of the seed and embryo.

Seed dormancy can be broken by various methods. Some the common methods include Nicking, stratification, soaking etc. Some

1. Nicking- In this methods, seeds are cut at the distal end by using a sharp tool like scalpel, a razor blade or a large nail clipper. This method is time consuming and laborious and applicable for laboratory use where limited number of seeds are used. This method is effective to break dormancy of seeds of *Acacia* species, *Albizia, Delonix* and *Terminalia*.

2. Stratification- This method is commonly used to break embryo dormancy. This is a simple, inexpensive and effective method of overcoming seed dormancy. Warm stratification is applied for seeds that have immature embryos; cold stratification is effective for seeds that have both have immature embryos and physiological dormancy. In warm stratification, seeds are placed in a moist medium such as sand, sawdust, vermiculite, peat moss, or a mixture of two media in a loosely covered container at 20 to 25^{0}C for various periods of time depending on the species.

Cold stratification also known as moist chilling involves placing seeds in a moist medium of sand, sawdust, peat moss, vermiculite or any other porous material in a loosely covered container (e.g. plastic bag) at 1-5^{0}C for the different period of time depending upon the species. Cold stratification method is used to break dormancy of seeds such as *Abies, Phellodendron wilsonii, Quercus gilva, Quercus glauca, Elaeocarpus japonica* etc.

3. Scarification- In some seeds, seed coat is very hard and impermeable to water. This is observed in case of family leguminosae. Such dormancy due to seed coat in such seeds can be broken by sharp knife or razor or with sand paper. So, scarification is the process of breaking, scratching and softening the seed covering so that it become permeable to water. Scarification can be achieved by three different treatments.

i. Mechanical scarification

ii. Acid scarification

Iii. Hot water scarification

4. Soaking in water- This is simplest method to break seed dormancy in which seeds are soaked in water for 2 to 48 hours which activates enzymes and mobilizes reserves, soften the seed coat and leaches out chemical inhibitors. This method have been practiced for species like *Acacia, Albizia, Grevillea robusta* and *Pinus.*

5. Light- Some seeds including seeds of wild flowers produce small seeds are exposed to light to break their dormancy.

6. Double dormancy- Some seeds need more than one methods to break their dormancy. E.g. some seeds need stratification followed by exposure to light to break their dormancy.

7. Dry storage- Some seeds need to store for some days after harvesting because they remain dormant for many days after harvesting. If they are dried and stored for a specific period in dry conditions, their dormancy will be overcome. Such dormancy may be few days to several months.

8. Chilling treatment- Sometimes seeds of some plants are stored at very low temperature e.g. 2-5^{0}C. Seeds are ready to germinate after chilling treatment. The period of chilling treatment may vary from species to species.

9. Chemical Treatment- Chemicals like potassium nitrate (0.2%), Gibberellic acid (200-500 ppm) or thiourea (0.5 to 0.3 %) are used to soak seeds in it. Seeds of some fruit plants like sweet orange and other species of citrus are soaked in GA to accelerate germination.

10. Treatment with Plant growth regulators- Application GA3 (Gibberellic acid) is very common method used for breaking seed dormancy of seeds as well as vegetative propagules like corms, bulbs, rhizomes, suckers etc. Ethylene and cytokinins are also used for breaking dormancy of some other seeds.

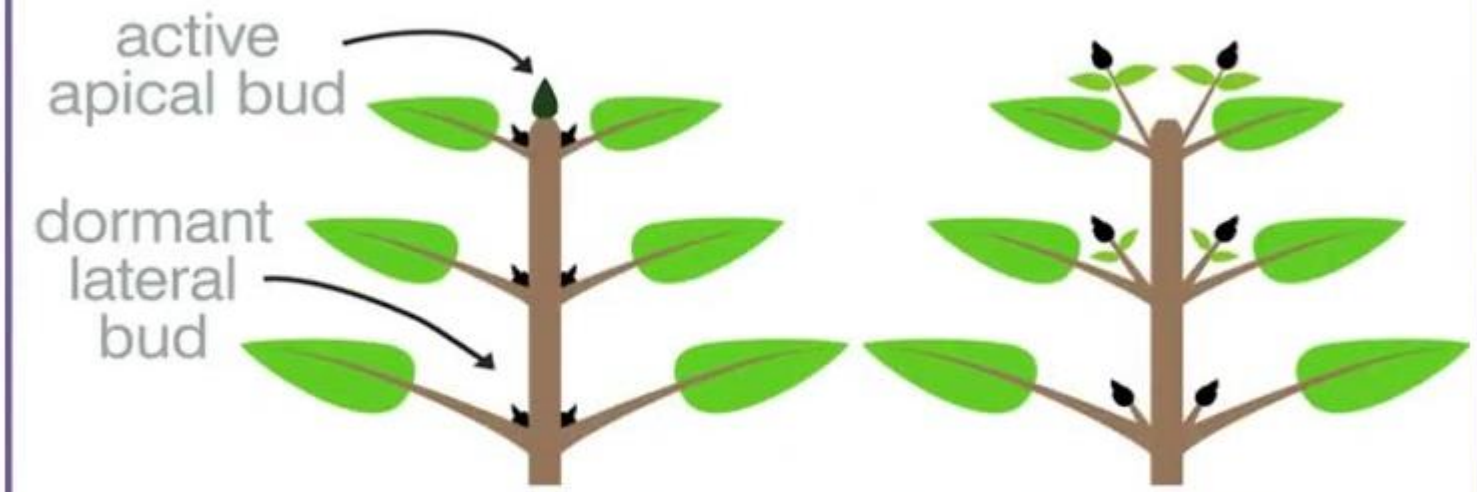
Bud Dormancy

- Deciduous fruits and nuts stop growing in late summer or fall, drop their leaves, and are dormant during winter, then resume growth in the spring. This synchrony between plant and environment is important to the survival of the plant. Growing plants are non-hardy and incapable of becoming hardy, so dormancy during winter is necessary to survival.
- However, buds can stay in dormant stage because of some other inappropriate environmental conditions and because of an inhibitory effect of another plant organ such as apical bud (Apical dominancy).

- Dormancy is the general term used to denote the visibly inactive state of buds.
- The three kinds of dormancy are as follows.
- **1. Ecodormancy (quiescence).** Buds are dormant as a result of external conditions unfavorable to growth.
- **2. Paradormancy (correlative inhibition).** Buds are dormant from the inhibitory influence of another plant part, as the dormancy of lateral buds due to the dominance of the shoot terminal (Apical dominance).
- **3. Endodormancy (rest).** Buds are dormant because of internal physiological blocks that prevent growth even under ideal external conditions for growth. Chilling temperatures above freezing terminate endodormancy.

- The onset of endodormancy is the transition in autumn from ecodormancy or paradormancy to endodormancy (rest).
- Typically, a plant adapted to the temperate zone has a grand period of growth during the first half of summer, after which growth ceases and terminal buds form. In some plants the cessation of growth is induced by shortening day length in late summer. At the beginning of this period, the buds are quiescent and may be forced into growth by factors such as pruning, defoliation, irrigation, nitrogen fertilizer, or long days. In autumn, the onset of endodormancy begins. During this time, endodormancy becomes progressively deeper until some time in October, November, or December in the Northern Hemisphere, depending on the species or variety.

Apical dominance



is used to control a tree's growth
by cutting the more dominating bud.

Auxin transport induces apical dominance

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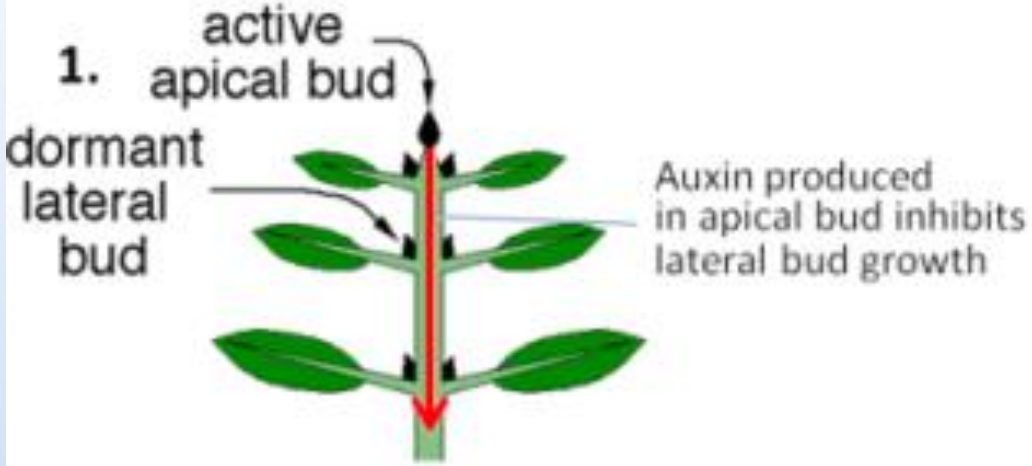

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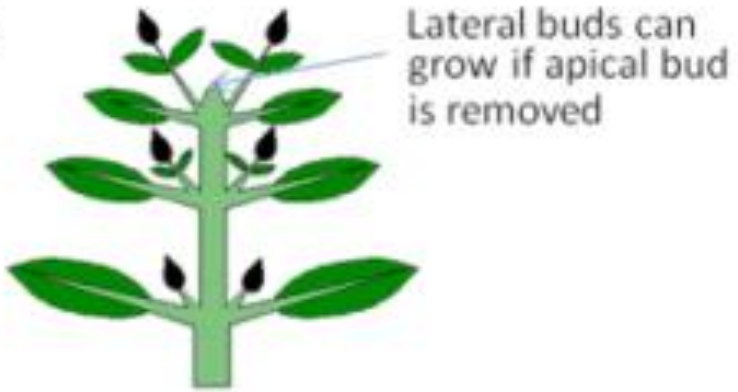

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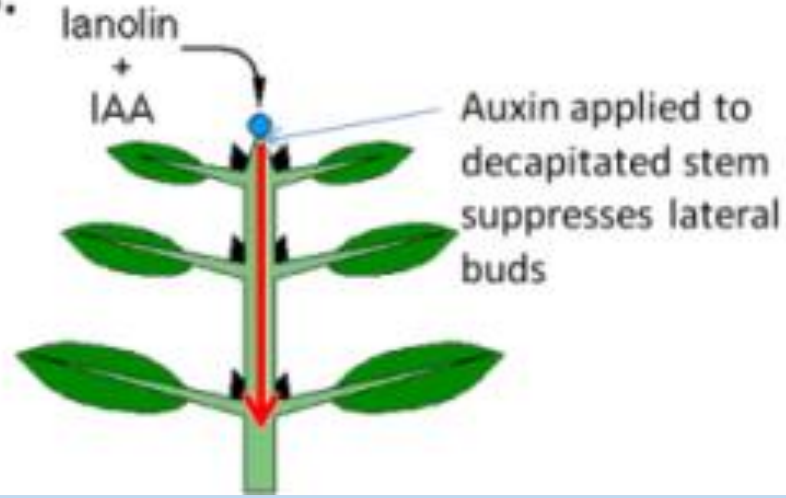

4.

Methods for breaking bud dormancy

- Chilling method to break bud dormancy as in seed dormancy.
- Photoperiod to break bud dormancy
- By using growth promoting hormones to break bud dormancy such as gibberellins, cytokinins and ethylene.

Chilling Requirement in Prennial Plants

- Endodormancy can be broken by chilling requirement.
- The temperature limits needed to meet the the chilling requirement may differ according to the species.
- These temperature limits are between 0-7 °C in some horticultural species and can reach up to 10 °C in some species.
- How long must the plant remain at these temperatures so that endodormancy can be broken?
- This period varies between 100-2700 hours in perennial horticultural plants. It is between 400-1500 hours in temperate zone regions.

- Chilling requirement can change basedon the bud types. Chilling requirement in generative buds (flower buds) of most of the species such as peach, sweet cherry and apple etc. is shorter than in vegetative (leaf) buds.
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What will be happen if chilling requiremnt does not meet?

- Leafing is reduced or no foliation at all,
- Most of the flower buds drops in stone fruit species,
- Irregular flowering occurres in pome fruit species,
- Since the flowering period is prolonged, fertilization cannot occur properly, at the end, yield decreases.

FLOWERING

- Conversion of vegetative buds to the generative buds.
- For the begining the flowering;
    - Carbohydrates in plant body
    - Healthy leaf area
    - Light
    - hormones synthesized in leaves are necessary factors.
- Flowering can bestimulated by external plant growth regulator applications.
- E.g., gibberellic acid treatments in cabbages, carrots stimulates flowering.

PHOTOPERIODISM

- Photoperiodism is nother factor for flowering.
- It is a reaction to day length and is a hormonal control.
- Leaves sense the length of the day, then produce florigen (flowering hormone) which is synthesized in leaves, then transported near buds via phloem, causes vegetative buds turn into flower buds.

DROPS IN FRUIT TREES

- Not all flowers that bloom on fruit trees turn into fruit.
- If the all blooming flowers turn into fruits, the tree cannot feed all of these small fruits, as a result, the tree loses its strength and poor quality fruits are formed.
- For this reason, it is sufficient for 13% of the flowers to turn into fruit for optimum yield in apples.
- This rate is 1% in avocado.
- So, some of flowers and young fruit drop during spring period or at the beginning of summer time.

Drops occur in three different times in fruit trees:

- 1. **The first drop:** It is a flower drop and occur in a very short time after flowering in spring. The female organ is defective in dropped flowers.
- 2. **The second drop:** Flowers and very young fruits drop and it occur two weeks after the first drop. Fertilization did not occur in the dropped young fruit and flowers.
- 3. **The third drop** is called as June drop because it occurs in June, one month after the second drop. In this stage, fertilized fruits that have reached a certain size and also unfertilized fruits are dropped. The main reason of this drops is water and nutrient deficiency in the soil. Each June, many home fruit growers are amazed and horrified when they find small, undeveloped fruit lying on the ground under their fruit trees.

- **The hormones effective in drops are:**
- For the 1st and 2nd drops: Auxin
- For the June drops: Auxin and ethylene

Senescence in Horticultural Plants

- Senescence is a programmed event and there are many external factors that affect senescence in horticultural plants.
- **Partial senescence:** Deterioration or death of plant organs (fruit, flower, leaf). (In perennial fruit trees)
- **Complete senescence:** The senescence and death of an entire plant except its seeds. (In annual or biennial horticultural species)
- Senescence in perennial plants occurs gradually, in the form of wear (abrasion), and it can be prevented by rejuvenation pruning.

Alternate Bearing (or Biennial bearing)

- It happens mostly in fruit trees.
- Alternate bearing is the tendency of some fruit trees to produce much greater than average crop in one year («on year») and much lower than average crop in the following year («off year»).
- An alternate bearing tree (or branch) is one that does not bear a regular crop year after year; rather, heavy yields are followed by extremely light ones and vice-versa.
- It is a common phenomenon in many fruit tree species and causes severe labor and economic problems, because the production is not the same or nearly the same (in terms of quantity) year by year and in many cases it cannot be projected by the grower.
- Olive, pecans, mango, pistachio nut, some apple cultivars, hazelnut show high tendency to alternate bearing.

- The olive tree is widely known for its strong tendency for alternate bearing (biennial bearing), which severely affects the fruit yield from year to year. A large production in year 1 removes most of the various carbohydrates, organic nitrogen components and other essential nutrients, making the available stock insufficient to produce a new crop in year 2. Some farmers believe that- through supplying olive trees with excessive nutrients in year 1 or in year 2- they can minimize the phenomenon of alternate bearing. However, researchers have proven that summer pruning and sophisticated irrigation are some of the methods that have some chances of achieving (partial) normalization of fruit production.

Why we do not want alternate bearing in fruit trees??

- In «on year», all stored carbohydrates in plant body is used for ripening of fruits and so, all other organs such as new formed branches enter the winter without storing carbohydrates and they can be damaged by low winter temperatures.
- The tree may go into late dormancy as it tends to store enough nutrients as it goes into winter. It can be damaged by frost.
- Many but small, colorless, tasteless fruits occur in «on year». They are cheaper.
- In «off year», the fruit amount is lower but these are big and high quality and also the price is much higher.
- It is harmful to the foreign trade balance of a country. Because, importer countries want to find the desired amount of fruit at any time.

Precautions for alternate bearing

- To set the physiological balance in plant body by some cultural applications such as;
    - Fertilization
    - Irrigation
    - Pruning
    - Fruit thinning
    - Pest and disease management
- Using dwarf rootstocks