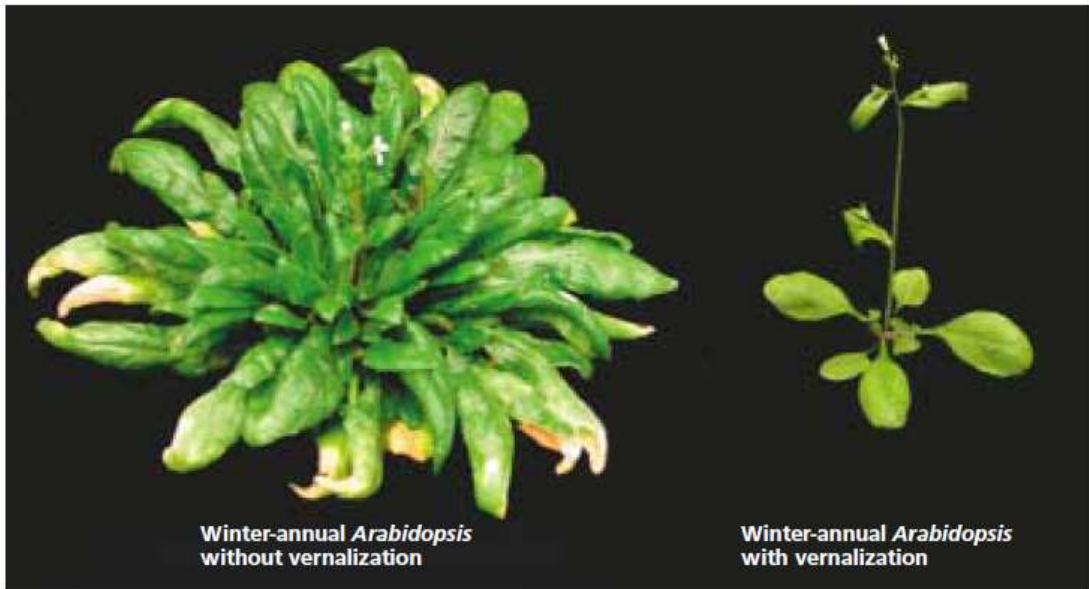


Vernalization

Promoting flowering with cold

- Vernalization is the process whereby flowering is promoted by a cold treatment given to a fully hydrated seed or to a growing plant.
- Dry seeds do not respond to the cold treatment.
- Due to vernalization the vegetative period of the plant is cut short resulting in an early flowering.
- Also called as yarovization.
- Without the cold treatment, plants that require vernalization show delayed flowering or remain vegetative.
- In many cases these plants grow as rosettes with no elongation of the stem.



Winter-annual *Arabidopsis*
without vernalization

Winter-annual *Arabidopsis*
with vernalization

History

- Klippart,1857- first noticed the low temperature requirement for flowering while working with winter wheat and spring wheat.
- Lysenko,1938-used the term vernalization for a low temperature promotion of flowering in plants.
- Chourad ,1960- defined vernaliation as “acquisition or acceleration of the ability to flower by a chilling treatment”.

Vernalization

- For vernalization the seeds are allowed to germinate for some time and then are given cold treatment 0°C to 5°C.
- The period of cold treatment varies from few days to many weeks.
- After the cold treatment the seedlings are allowed to dry for sometime and then sown.
- Vernalization prepares the plant for flowering.
- The cold stimulus usually perceived by the apical meristems. but in some species all dividing cells of roots and leaves may be the potential sites of vernalization eg. *Leennario biennis*.

- Vernalization induces the plant to produce a hormone called vernalin. It was discovered by Melcher (1936).
- The vernalization stimulus can be transmitted from one plant to another through grafting.
- The age of the plant is an important factor in determining the responsiveness of the plant to the cold stimulus and it differs in different species.
- The suitable temperature for vernalization ranges between 1 to 6°C.
- At higher temperature from 7°C onwards response of the plant is decreased.
- A temperature of about 12 to 14°C is most ineffective in vernalizing the plant.

- The vernalization is an aerobic process and requires metabolic energy.
- In the absence of oxygen cold treatment becomes completely inefficient.
- Sufficient amount of water is also essential.
- Vernalization of dry seeds is not possible.

Mechanism of vernalization

Two theories..

- 1. Phasic development theory
- 2. Hormonal theories.

Phasic development theory

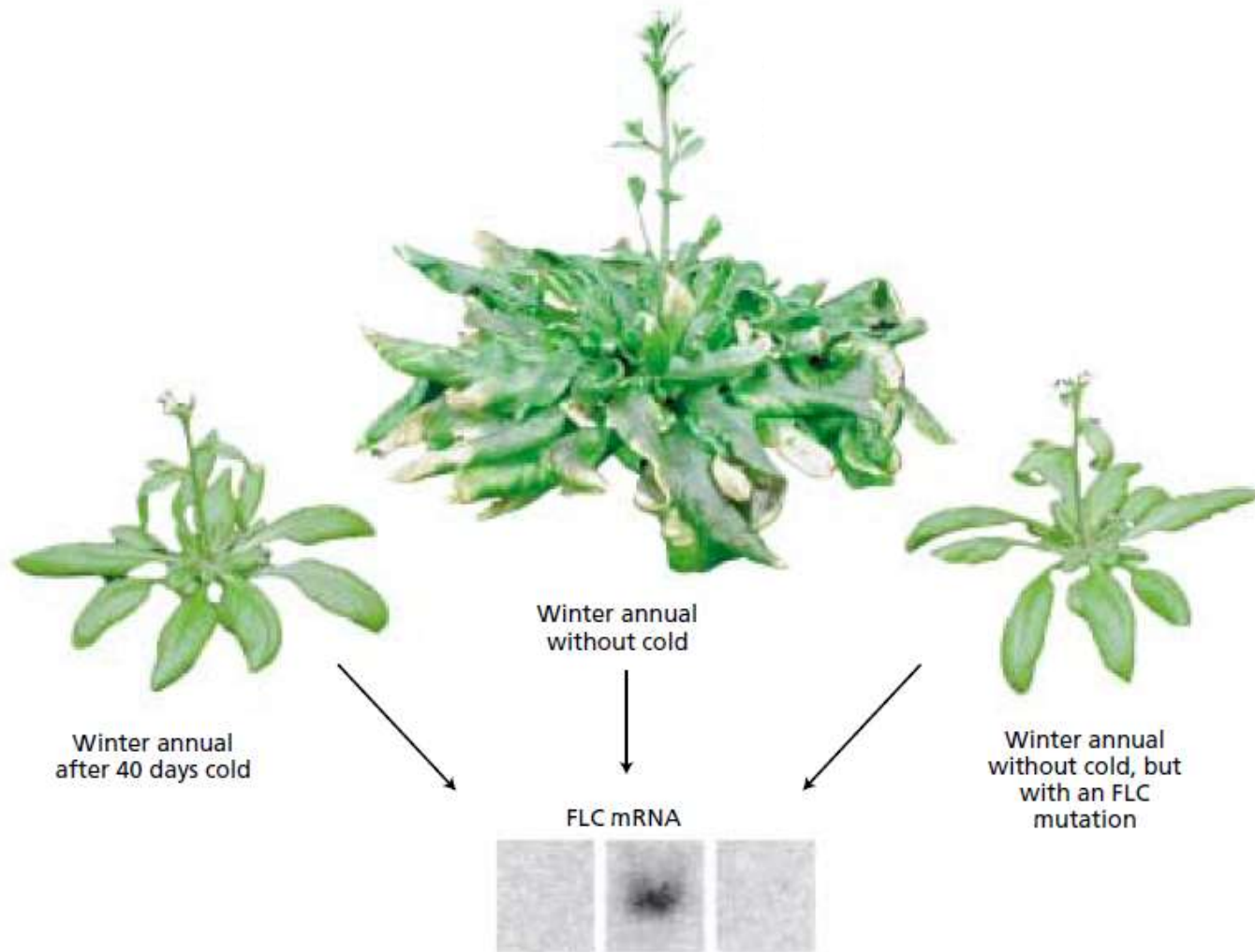
- Proposed by Lysenko in 1934.
- According to this theory there is a series of phases in the development of a plant.
- Each phase is stimulated by an environmental factor such as temperature, light, etc.
- Commencement of one phase will take place only after the completion of the preceding phase.
- There are two phases
- 1. Thermophase
- 2. Photophase
- Thermophase depends on temperature. vernalization accelerates thermophase.
- Thermophase should be followed by photophase which requires light.

Hormonal theories

- Melcher (1939)
- He proposed that chilling treatment induces the formation of a new floral hormone called vernalin.
- This hormone is transmitted to other parts of the plant.
- He grafted a vernalized plant with an unvernallized plant.
- The unvernallized plant also initiates flowering.
- The hormone, vernalin diffuses from the vernalized plant to the unvernallized plant and induces flowering.

Epigenetic Changes in Gene Expression

- Vernalization May Involve Epigenetic Changes in Gene Expression.
- Changes in gene expression that are stable even after the signal that induced the change (in this case cold) is removed are known as **epigenetic regulation**.
- One model for how vernalization affects flowering is that there are stable changes in the pattern of gene expression in the meristem after cold treatment.
- The involvement of epigenetic regulation in the vernalization process has been confirmed in the LDP *Arabidopsis*.
- A gene that acts as a repressor of flowering has been identified: **FLOWERING LOCUS C (FLC)**. **FLC is highly expressed in nonvernalized** shoot apical meristems (Michaels and Amasino 2000).
- After vernalization, this gene is epigenetically switched off by an unknown mechanism for the remainder of the plant's life cycle.



Devernalization

- The reversion of vernalization by high temperature treatment is called devernalization.
- Devernalization is effected by treating the vernalized seeds or buds with high temperature.
- Lang et al (1957) demonstrated that application of gibberlins can replace the cold treatment for vernalization in certain biennial plants.

Practical applications

- Due to vernalization the vegetative period of the plant is cut short resulting in an early flowering.
- Vernalization increases the resistance of plants to fungal diseases.
- It increases the cold resistance of plants.
- In the biennials, vernalization induces early flowering and early fruit setting.
- Flowering can be induced by grafting and this feature is used in horticulture.
- It also helps in crop improvement.

Thank you