

Vernalization

❖ Presented By...

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Introduction

- in many plants the flowering is influenced not only by the correct photoperiod but also by temperature.
- In annuals the flowering is primarily affected by the photoperiod.
- The effect of temperature is secondary to light, a biennial plant, on the other hand, grows only vegetatively during the first season and will not initiate.
- Flowering until it has been exposed to prolonged period of low temperature of the winter.
- The term vernalization was coined by **T.D.Lysenko** in **1920s**.
- Other important scientists who have contributed to the study on vernalization were **F.G.Gregory** and **O.N.Purvis (1961)**.

- It allows the plant to reach vegetative maturity before reproduction can occur.
- The condition occurs in winter varieties of some annual food plants (e.g., Wheat, Barley, and Rye).
- some biennial (e.g., Cabbage, Sugar beet, Carrot) and perennial plants (e.g., Chrysanthemum).
- The annual winter plants also possess spring varieties. The spring varieties are planted in spring.
- They come to flower and bear fruits prior to end of growing season.

- They germinate and over winter as small seedlings , resume growth in spring , and harvested usually about mid summer.
- The over wintering cold treatment , or vernalization , renders the plants sensitive to long day.
- If seeds of the winter strain are sown in the fall , however, the germinated seedlings are subjected to an over wintering low temperature treatment.



Winter-annual Arabidopsis
without vernalization



Winter-annual Arabidopsis
with vernalization

- **The effect of temperature is secondary to light.**

➤ A biennial plant, on the other hand, grows only Vegetatively during the first season and will not initiate flowering until it has been exposed to prolonged periods of low temperature of the winter.

➤ **The biennials like cabbages, kales, carrots, foxglove and beets need absolute cold requirement for flowering.**

• Technique of vernalization:

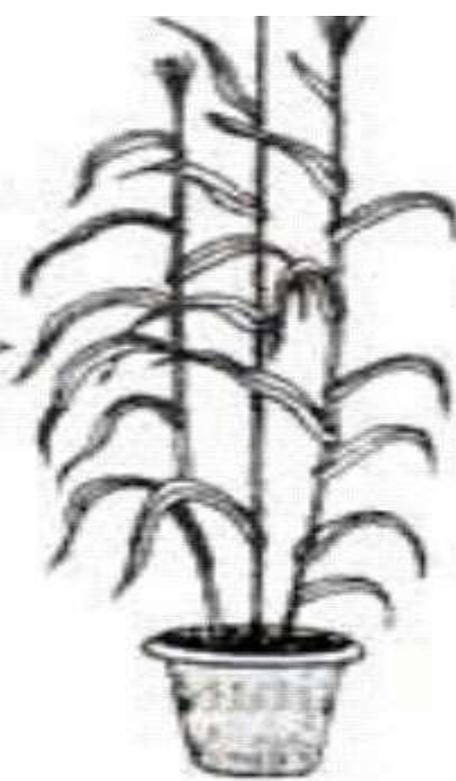
- **Although differing in details, the technique of vernalization is essentially very simple.**
- **The seed is first soaked in water and is allowed to germinate.**
- The seedlings resume growth in spring.
- They bear flowers and fruits in summer.

- It was found by Lysenko (1928), a Russian worker that the cold requiring annual and biennial plants can be made to flower in one growing season by providing low temperature treatment to young plants or moistened seeds.
- He called the effect of this chilling treatment as vernalization.
- Vernalization is, therefore, a process of shortening of the juvenile or vegetative phase and hastening flowering by a previous cold treatment.

CHILLED FOR TWO MONTHS
AT 5°C, PLANTED AT
ORDINARY TEMPERATURE

Vernalised

SLIGHTLY
GERMINATED
SEED



NO CHILLING, PLANTED
AT ORDINARY TEMPERATURE

Not
Vernalised

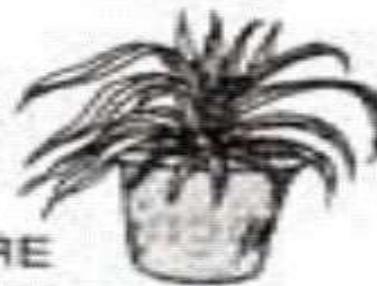


Fig. 15.33. Experiment to show effect of vernalization on Winter Rye.

- **A similar phenomenon is to be seen in certain varieties of cereals.**
- **In cold countries, there are cereals of two physiological kinds –the winter cereals and the spring cereals.**
- **The winter variety is sown in early autumn i.e. in the month of September or October to make them flower in the following summer.**

- If they are sown in the spring along with the spring variety, they grow vegetatively but fail to produce ears or flowers.
- **Exposure to low temperature of the winter is evidently essential for the flowering of winter varieties.**
- It has been shown by several worker that this requirement of low temperature in nature can be satisfied artificially in laboratories in the absence of the winter season and the plant may be made to flower in summer season.

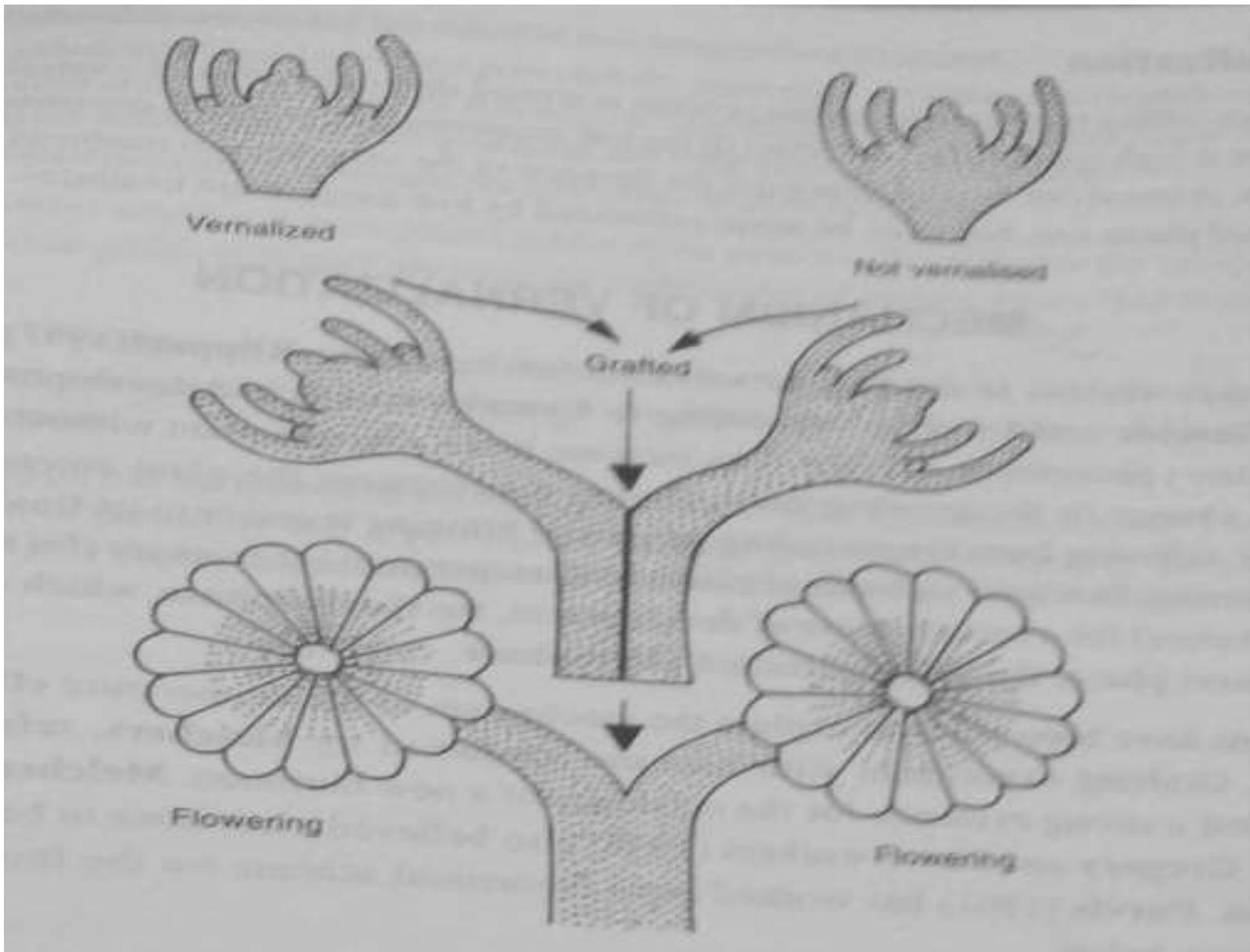
✓ **For example,** If a biennial seed is germinated and is then exposed to low temperature (0 – 5 degree C) for few weeks, it will behave as if it has gone through the cold winter after a year of growth.

➤ **Similar treatment will enable the winter variety of wheat or rye to flower even if they are shown in the spring.**

Vernalization and flowering:

- In nature, vernalization takes place in the seed stage in the annuals.
- Biennials and Perennials are however vernalized at a much later stage.
- In Biennials, vegetative growth takes place in the first season, and the vernalization takes place in the following winter.

- The site of vernalization, in the case of biennials and perennials, is believed to be the growing point (apical bud).
- According to **chailakhyan** (1968) there are two types of chemicals responsible for flowering: **Gibberellins** and **anthesin**.
- he assumed that the cold treatment resulted in the production of **vernalin**.
- **Gibberellins**: if the cold-treated plants are then sown in long days the vernalin is converted into.....
- **Anthesin**: during grafting the vernalised one produces vernalin while the non-vernalized one produced.....
- Then flowering is believed to occur due to combined effect of both.



The flowering stimulus resulting from appropriate vernalization of the apex may pass from one plant to a grafted unvernalsized partner.

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

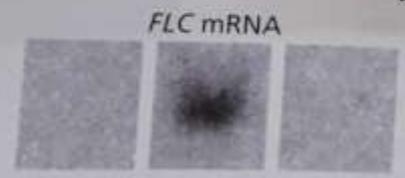
- Vernalization May Involve Epigenetic Changes in Gene Expression.
- Changes in gene expression that are stable even after the signal that induced the change (in this case cold) is removed are known as **epigenetic regulation**.
- One model for how vernalization affects flowering is that there are stable 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.



Winter annual after 40 days cold

Winter annual without cold

Winter annual without cold, but with an *FLC* mutation



FLC mRNA

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.

❖ Importance of vernalization

- (i) Vernalization can help in shortening the juvenile or vegetative period of plant and bring about early flowering. It is not only applicable to temperate plants but also to some tropical plants, e.g., Wheat, Rice, Millets, Cotton,**
- (ii) It increases yield, resistance to cold and diseases, and**
- (iii) Kernel wrinkles of Triticale can be removed by vernalization.**

☐ Reference :

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Thank You.....