

Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Second Year)

Subject: Botany

Course Code: BOC 104

Course Title: Plant Physiology

Unit 9: Plant response to light and temperature

Module Name: Vernalization

Module No: 60

Name of the Presenter: Sonam D. Madgaonkar

Notes

INTRODUCTION

Some plants flower only when they are subjected to the correct photoperiod

In many plants, apart from correct photoperiod, temperature is also an important factor which affects initiation and development of reproductive organs.

In annuals effect of photoperiod is primary, whereas in biennials, vegetative growth takes place during the first year and only after a prolonged exposure to cold temperature of winter, they will flower in the next season.

Vernalization is the process by which flowering is promoted by prolonged exposure to the cold.

Plants can be induced to flower by exposure to low temperature.

Vernalization prepares the plant for flowering.

Due to Vernalization the vegetative period is cut short resulting in early flowering.

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.

Common in biennials and some perennial plants.

Vernalization requiring plants include: Winter annuals (Wheat and Barley); most biennials (Carrot, Beet, Celery and Black henbane) as well as some perennials (Carnation).

VERNALIZATION

The word 'Vernalization' comes from the Latin Vernalis, which means 'of spring' — so Vernalization means to make 'spring-like'.

Vernalization is the promotion of flowering in response to prolonged low temperatures.

This response evolved in plants that adapted to regions where the winters are harsh and the growing season relatively short.

These plants germinate in the autumn, and are exposed to low temperatures during winter.

When the weather warms up, they flower, ensuring that seed development occurs under favorable conditions.

HISTORY OF VERNALIZATION

Klippart, (1857) first noticed the low temperature requirement for flowering while working with winter Wheat and spring Wheat.

Triofim Denisovich Lysenko, (1928) termed the conversion of the winter variety into the spring variety by low temperature or chilling treatment as vernalization.

Chourard, (1960) defined vernalization as 'acquisition or acceleration of the ability to flower by giving chilling treatment'.

THEORY OF VERNALIZATION

Plant development comprises of certain stages and the completion of one stage is necessary for the commencement of the next one.

Each of these stages requires suitable doses of temperature, humidity, light, aeration etc.

In lack of any of these conditions further development of plant is checked.

They are as follows:

THERMOSTAGE: First stage and is also referred to as vernalization stage or Lysenko stage.

Conditions required for successful passage are

Temperature- low temperature ranging from 0°C to 20°C according to species and strains.

Moisture- presence of moisture is equally important for completion of this stage.

Aeration- proper aeration is very important and in several cases it becomes a critical factor.

Time required for completion of thermostage varies with environmental conditions and depends on the nature of plants itself.

Response of vernalization also decreases if the period of vernalization is interrupted by periods of heat treatments.

Lysenko, stated that flower initials are laid down after this stage has been passed.

PHOTOSTAGE: Plant passes through the next stage called photostage.

There is a pronounced effect of the relative length of day and night on the production of flowers.

This phenomenon is called as photoperiodism.

THIRD STAGE: Poorly known.

Necessary for seed formation.

It has some connection with the formation of sexual elements and is associated with gametogenesis.

Photoperiod requirement for the commencement of this stage is a little shorter than required for the completion of photostage.

PROCESS OF VERNALIZATION

Vernalization is the process whereby flowering is promoted by cold treatment given to a fully hydrated seed or to an actively growing plant.

Seeds are allowed to germinate for some time followed by giving a cold treatment of 0°C to 5°C.

The period of cold treatment varies from a few days to many weeks from species to species.

Seedlings are allowed to dry for some time and then sown.

Should not be sown immediately after the cold treatment.

Drying period should not be a very long one as with the increase in the drying period the response of vernalization decreases and it may decrease till the seedlings are completely devernalized.

Response to vernalization also decreases if the period of vernalization is interrupted by periods of heat treatment.

It is also possible to revernalize the devernalized seedlings.

Isolated embryos can also be vernalized.

Vernalization prepares the plants for flowering.

PERCEPTION OF THE COLD STIMULUS

Cold stimulus is perceived by the apical meristem.

Wellensiek, (1964) found out that the vernalization of the excised or isolated leaf and root of *Lunaria biennis* has shown that all dividing cells including those in roots or leaves may be the potential sites of vernalization.

PRESENCE OF A FLORAL HORMONE

Perception of the cold stimulus results in the formation of a floral hormone which is transmitted to other parts of the plant.

Cold stimulus in some cases may even be transmitted to another plant across a graft union.

For E.g. if vernalized henbane plant is grafted to an un-vernalized henbane plant, the latter also flowers.

Melchers (1939), named the floral hormone as Vernalin.

MECHANISM OF VERNALIZATION

Two theories have been proposed to explain Vernalization:

Phasic Development Theory

Hormonal Theories

PHASIC DEVELOPMENT THEORY

Proposed by Lysenko, (1934).

Growth (increase in size) and development (the progressive change in the characteristic of the new organs) are two distinct phenomena.

According to this theory, there is a series of phases in the development of an annual plant which must occur in some predetermined sequenced.

Commencement of one phase will take place only after the completion of the preceding phase.

Each phase is stimulated by environmental factors such as temperature, light, aeration etc.

HORMONAL THEORIES

Proposed by Lang and Melcher, (1947).

Proposed that chilling treatment induces the plant to produce a new floral hormone called Vernalin.

Hormone can be transferred to other parts of the plant thereby promoting flowering.

According to this theory, the precursor **A** is converted into a thermolabile compound **B** during cold treatment.

Under normal conditions **B** changes into **C** which ultimately causes flowering.

But at higher temperature **B** is converted into **D** and flowering does not take place (devernalization).

DEVERNALIZATION

The reversion of vernalization by high temperature treatment is called devernalization.

Devernalization is carried out by treating the vernalized seeds or buds with high temperature (25-40°C).

Degree of devernalization decreases if the duration of the cold treatment has been longer.

Devernalized plant can again be vernalized by subsequent low temperature treatment.

VERNALIZATION AND GIBBERELLINS

Lang et al., (1957) demonstrated that application of gibberellins can replace the cold treatment for vernalization in certain biennial plants (eg. Henbane).

This plant remains vegetative and retains its rosette habit during the first growing season and after passing through the winter period, flowers in the next season.

Treatment with gibberellins induces the plant to flower in the first year itself.

Gibberellins probably through stem elongation trigger some reaction leading to flowering.

PRACTICAL APPLICATIONS OF VERNALIZATION

Vernalization increases the cold resistance of plants.

Reduces vegetative period of development and induces early flowering.

Helps in crop improvement thereby accelerating plant breeding work.

Flowering can be induced by grafting.

Increases the resistance of plants to fungal diseases.

Crops can be grown in regions where they do not naturally reproduce.

In India, early flowering has been achieved in crops like Rice, Wheat, Jute and Pulses.