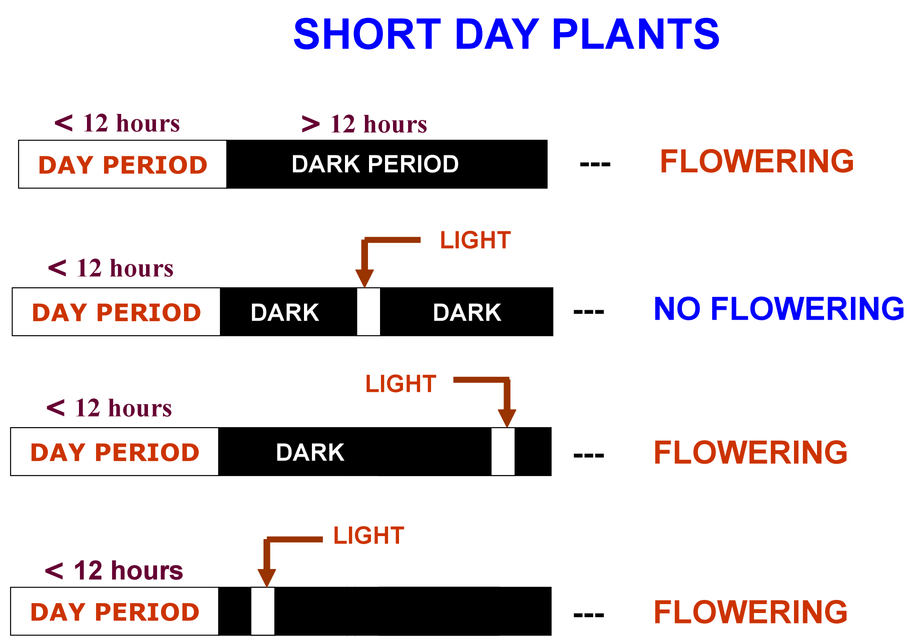
15. PHOTOPERIODISM

Photoperiodism is the phenomenon of physiological changes that occur in plants in response to relative length of day and night (i.e. photoperiod). The response of the plants to the photoperiod, expressed in the form of flowering is also called as photoperiodism. The phenomenon of photoperiodism was first discovered by Garner and Allard (1920).Depending upon the duration of photoperiod, the plants are classified into three categories.

1. Short day plants (SDP)
2. Long day plants (LDP)
3. Day neutral plants (DNP)

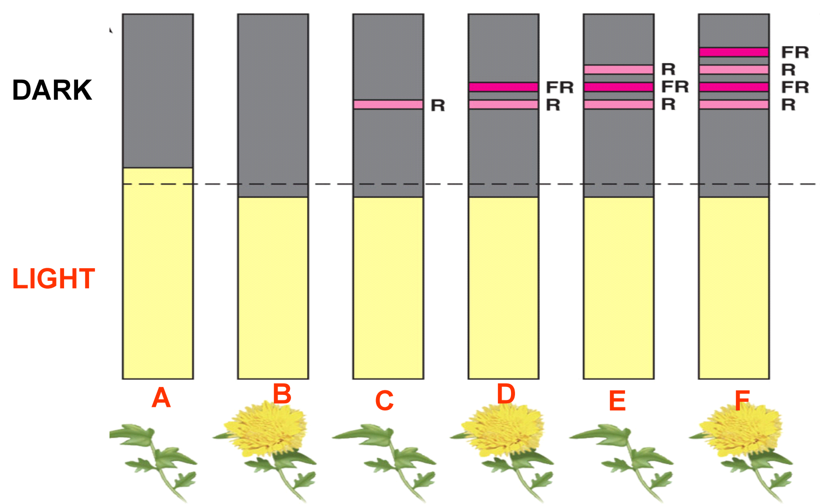
1. Short day plants



These plants require a relatively short day light period (usually 8-10 hours) and a continuous dark period of about 14-16 hours for subsequent flowering. These plants are also known as long-night plants

E.g. Rice, coffee, soybean, tobacco and chrysanthemum

- In short day plants, the dark period is critical and must be continuous. If this dark period is interrupted with a brief exposure of red light (660-665 nm wavelength), the short day plant will not flower.
- Maximum inhibition of flowering with red light occurs at about the middle of critical dark period.
- However, the inhibitory effect of red light can be overcome by a subsequent exposure with far-red light (730-735 mm wavelength)
- Interruption of the light period with red light does not have inhibitory effect on flowering in short day plants.
- Prolongation of the continuous dark period initiates early flowering.



SHORT DAY PLANTS - FLOWERING

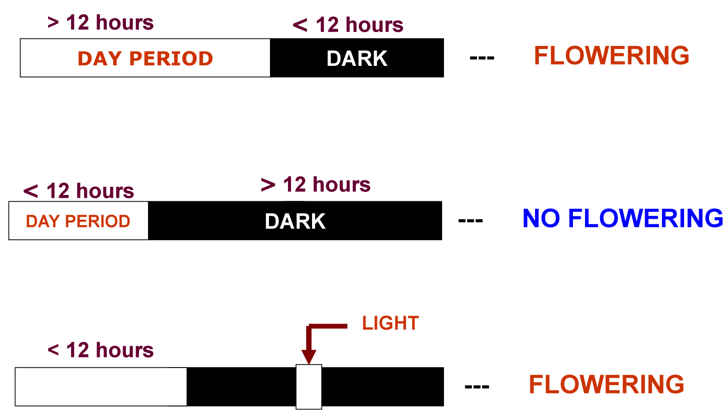
2. Long day plants

These plants require longer day light period (usually 14-16 hours) in a 24 hours cycle for subsequent flowering. These plants are also called as short night plants.

E.g. Wheat, radish, cabbage, sugar beet and spinach.

- In long day plants, light period is critical
- A brief exposure of red light in the dark period or the prolongation of light period stimulates flowering in long day plants.

LONG DAY PLANTS



3. Day neutral plants

These plants flower in all photoperiod ranging from 5 hours to 24 hours continuous exposure.

E.g. Tomato, cotton, sunflower, cucumber, peas and certain varieties of tobacco.

During recent years, intermediate categories of plants such as *long short day plants* and *short long day plants* have also been recognized.

i. Long short day plants

These are short day plants but must be exposed to long days during early periods of growth for subsequent flowering. E.g. Bryophyllum.

ii. Short –long day plants

These are long day plants but must be exposed to short day during early periods of growth for subsequent flowering. E.g. certain varieties of wheat and rye.

Differences between short day and long day plants

	Short day plant	Long day plant
1	Plants flower when photoperiod is less than the critical day length	Plants flower when photoperiod is more than the critical day length
2	Interruption during light period with darkness does not inhibit flowering	Interruption during light period with darkness inhibit flowering
3	Flowering is inhibited if the long dark period is interrupted by a flash of light	Flowering occurs if the long dark period is interrupted by a flash of light
4	Long continuous and uninterrupted dark period is critical for flowering	Dark period is not critical for flowering
5	Flowering does not occur under alternating cycles of short day and short light period.	Flowering occurs under alternating cycles of short day followed by still shorter dark periods

Phytochrome

It is observed that that a brief exposure with red light during critical dark period inhibits flowering in a short day plant and this inhibitory effect can be reversed by a subsequent exposure with far-red light. Similarly, prolongation of the critical light period or the interruption of the dark period stimulates flowering in long-day plants.

This inhibition of flowering in short day plant and stimulation of flowering in long day plants involves the operation of a proteinaceous pigment called *phytochrome*. It is present in the plasma membrane of cells and it has two components, chromophore and protein. Phytochrome is present in roots, coleoptiles, stems, hypocotyls, cotyledons, petioles, leaf blades, vegetative buds, flower tissues, seeds and developing fruits of higher plants.

The pigment, phytochrome exists in two different forms i.e., red light absorbing form which is designated as *Pr* and far red light absorbing form which is designated as *Pfr*. These two forms of the pigment are photo chemically inter convertible. When *Pr* form of the pigment absorbs red light (660-665 nm), it is converted into *Pfr* form. When *Pfr* form of the pigment absorbs far red light (730-735 nm), it is converted into *Pr* form. The *Pfr* form of pigment gradually changes into *Pr* form in dark.

It is considered that during day time, the *Pfr* form of the pigment is accumulated in the plants which are inhibitory to flowering in short day plants but is stimulatory in long day plants. During critical dark period in short day plants, this form gradually changes into *Pr* form resulting in flowering. A brief exposure with red light will convert this form again into *Pfr* form thus inhibiting flowering.

Reversal of the inhibitory effect of red light during critical dark period in SDP by subsequent far-red light exposure is because, the *Pfr* form after absorbing far-red light (730-354 nm) will again be converted back into *Pr* form.

Prolongation of critical light period or the interruption of the dark period by red- light in long day plants will result in further accumulation of the *Pfr* form of the pigment, thus stimulating flowering in long-day plants.

Differences between Pr and Pfr forms of phytochrome

	Pr form	**Pfr form**
1	It is blue green in colour	It is light green in colour
2	It is an inactive form of phytochrome and it does not show phytochrome mediated responses	It is an active form of phytochrome and hence shows phytochrome mediated responses
3	It has maximum absorption in red region (about 680nm)	It has maximum absorption in far-red region (about 730nm)
4	It can be converted into Pfr form in red region (660-665nm)	It can be converted into Pr form in far red region (730-735nm)
5	It is found diffused throughout the cytosol	It is found in discrete areas of cytosol
6	The Pr form contains many double bonds in pyrrole rings	The Pfr form contains rearranged double bonds in all pyrrole rings

Significance of photoperiodism

Photoperiodism is an example for *physiological preconditioning*. The stimulus is given at one time and the response is observed after months. Exposure to longer photoperiods hastens flowering (E.g). In wheat, the earing is hastened. During long light exposure, *Pr* form is converted into *Pfr* form and flowering is initiated. If dark period is greater, *Pfr* is converted into *Pfr* form that inhibits flowering.

The important phytochrome mediated photo responses in plants include photoperiodism, seed germination, sex expression, bud dormancy, rhizome formation, leaf abscission, epinasty, flower induction, protein synthesis, pigment synthesis, auxin catabolism, respiration and stomatal differentiation.