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PHOTOPERIODIC CONTROL OF FLOWERING TIME IN PLANTS

Popular Article

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ABSTRACT

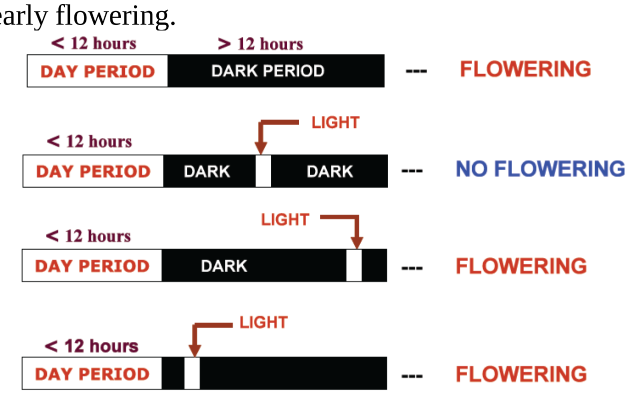
The rotation of the earth results in periodic changes in environmental factors such as day length and temperature. Developmental responses occur in plants to the relative lengths of light and dark periods. The circadian clock is the endogenous mechanism responsible for day-length measurement, and allows plants to anticipate these fluctuations and modulate their developmental programs to maximize adaptation to those environmental cues. Flowering is also a response to the changing in length of day and night as the season progresses. Because flowers produce seeds and flowering is crucially important for the plant to complete its life cycle.

Introduction

Photoperiodism is the phenomenon of physiological changes that occur in plants in response to relative length of day and night (i.e. photoperiod). As word derivation itself says Photo means light and Period means a specific length of time. Response of plants to the photoperiod is expressed in the form of flowering is also called as photoperiodism. This phenomenon of photoperiodic control was first discovered by Garner and Allard (1920). They worked with the Maryland Mammoth, a large tobacco plant that didn't flower in the summer when most tobacco plants bloomed. Then Under controlled experiments they could manipulate the amount of light and dark periods, in winter it stimulated the flowering in Maryland Mammoth therefore flowering only occurred if the day length (amount of light) was 14 hours or less than that. Then they named this Maryland Mammoth a short-day plant because it required a light period *shorter* than a critical length to flower. Depending upon the duration of photoperiod, the plants are classified into three categories.

Short day plants (SDP): 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* and they flower in the late summer, fall or early winter.

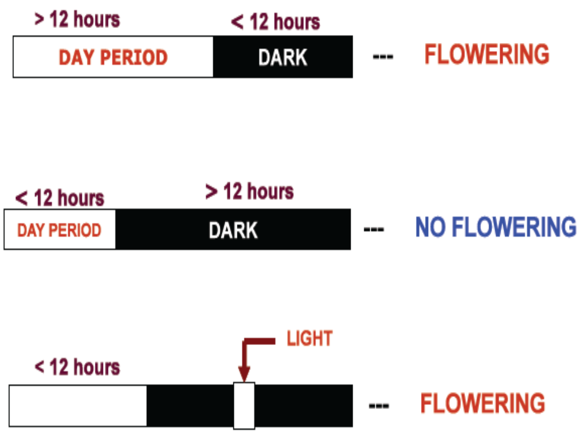
- In short day plants, the dark period is critical and must be continuous. If this dark period is interrupted with a brief exposure of red light (660-665 nm wavelength), the short day plant will not flower.
- Maximum inhibition of flowering with Red light occurs at about the middle of critical dark period.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



Examples: Rice, Coffee, Soyabean, Jowar, Cotton, Tobacco and Chrysanthemum.

Long day plants (LDP): 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.*

- 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.
- A few minutes of light during the night will shorten the night length, therefore causing flowering to occur.



Examples: Wheat, Radish, Cabbage, Lettuce, Sugar Beet, Spinach, and Many Cereal Varieties.

Day neutral plants (DNP): These plants flower in all photoperiod ranging from 5 hours to 24 hours continuous exposure. They flower when they reach a particular stage of maturity or because of some other cue like temperature or water, etc. This is the most common kind of flowering pattern.

Examples: 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 as follows:

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

Short –long day plants: These are long day plants but must be exposed to short day during early periods of growth for subsequent flowering. Examples: Certain Varieties of Wheat and Rye.

Phytochrome System Is a Way to Maintain the Circadian Rhythm: Phytochromes are Light-sensitive proteins and partially responsible for the timing of flowering. It's a Homodimer and Plants make 5 phytochromes (namely; PhyA, PhyB, as well as C, D, and E.) and Circadian rhythms are patterns of physiological change that follows a 24-hour cycle, day after day. These 24-hour cycles can be seen in a variety of physiological responses and are very predictable like, Pulse, Blood pressure, Temperature, Rate of cell division, metabolic rate, and Stomata opening and closing. This suggests the photoperiodic responses which governed by the interaction of daylight with innate circadian rhythms of the plant. Phytochromes exist in two interconvertible forms, P_R because it absorbs red (R; 660 nm) light;, P_{FR} because it absorbs far-red (FR; 730 nm) light. P_r form is constantly being synthesized by the plant.

These are the relationships:

- Absorption of red light by P_R converts it into P_{FR}.
- Absorption of far-red light by P_{FR} converts it into P_R.
- In the dark, P_{FR} spontaneously converts back to P_R.

Thus night length is responsible for resetting the circadian rhythm clock.

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. 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.

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