PHOTOPERIODISM

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Photoperiodism

The phenomenon of photoperiodism was first discovered by American plant physiologists, **W.W. Garner and H.A. Allard** (1920).

They made observations that tobacco variety, Maryland Mammoth, grew vegetatively in summer and flowered during winter.

On the other hand, soybean planted at different times of spring flowered nearly at the same time during summer.

Garner and Allard tested several factors which possibly could affect flowering and concluded that the critical factor was the length of the day.

Maryland Mammoth mutant of tobacco (right) compared to wild-type tobacco (left). Both plants were grown during summer in the greenhouse. (University of Wisconsin graduate students used for scale.) (Photo courtesy of R. Amasino.)

Important terms:

Several light-induced phenotypic changes collectively referred to as **photomorphogenesis**

The relative length of day and night is known as **photoperiod**.

The response of the plants to the photoperiod, expressed in the form of flowering is Photoperiodic induction is the phenomenon of conversion of leaf primordia into floral primordia under the influence of suitable inductive cycles in apical meristem. called as **photoperiodism**.

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Photoinductive cycle

Photoinductive cycle: The number of cycles required to induce flowering varies with different plant species.

Number of photo inductive cycles varies from plant to plant.

For example,

Xanthium requires only a single photo inductive cycle for flowering.

Glycine max, Salvia occidentalis and Plantago lanceolata require 2–4, 17 and 25 cycles respectively for flowering.

Critical photoperiod

Critical photoperiod refers to the limit of the photoperiod up to which the short- day plants come to flowering.

However, critical photoperiod is the limit above which the long day plant flowers.

The critical photoperiod varies from species to species.

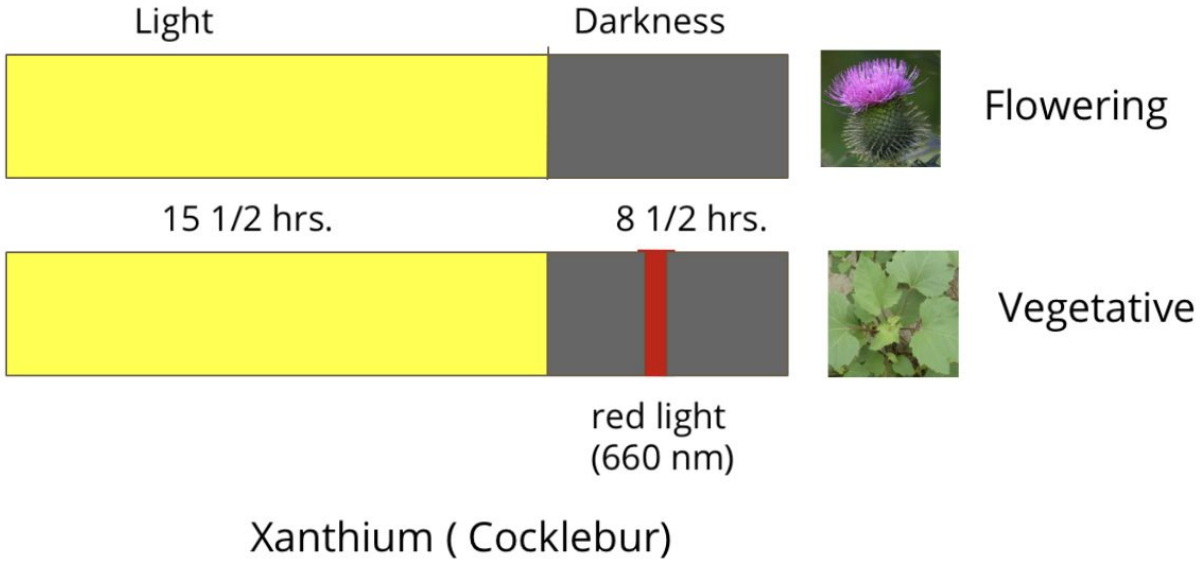
When exposed to 12 hours of light, both Xanthium and Hyoscyamus would flower although the former is a short-day plant (SDP) and the latter is a long-day plant (LDP).

Therefore, it is clear that the same photoperiod can be short day for one species but long day for the other. Hence, no absolute duration of light can be fixed for both a short day and a long day.

A short-day plant flowers below its critical photoperiod and the long-day plant flowers above its critical photoperiod.

Night breaks and critical night

Night breaks: An initial observation by **Hamner and Bonner** in 1938 was that the short- day cocklebur plant (Xanthium) would not flower if the long night was interrupted with a brief light period.



Critical dark period

The length of night or dark period in a 24-hour cycle required to inhibit flowering of long-day plants or to induce flowering of short-day plants is called critical dark period (critical night length, critical night).

It is considered that during day time, the Pfr form accumulates in the plants which are inhibitory to flowering in short day plants but is stimulatory in long day plants.

During critical dark period this form gradually changes into Pr form resulting in flowering in short day plants. A brief exposure with red light will convert this form again into Pfr form thus inhibiting flowering.

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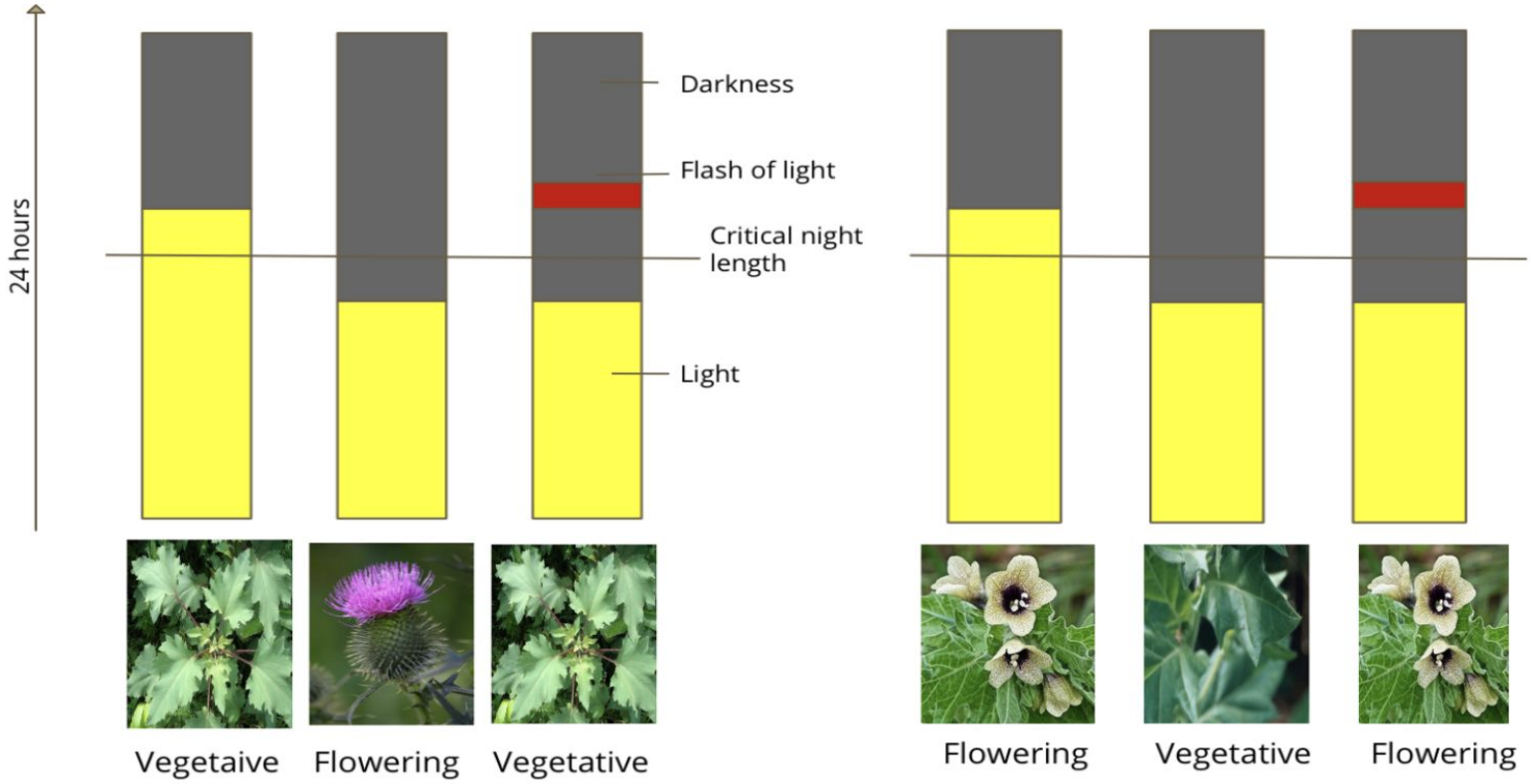

Short day (long night) Plant
e.g., *Xanthium*

Long day (short night) plant
e.g., *Hyoscyamus*

Classification of plants based on photoperiodism

Based on the requirement for day length, the flowering plants are categorized into five types.

1. Short day plants (SDP)
2. Long day plants (LDP)
3. Day neutral plants (DNP)
4. Long short day plants
5. Short long day plants

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. *Nicotiana tabacum* , *Oryza sativa* , Biloxi soybean, *Impatiens balsamina,* chrysanthemum, strawberry and xanthium

Rice

Coffee

Chrysanthemum

Strawberry

Xanthium

1. Short day plants

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)
- Prolongation of the continuous dark period initiates early 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. *Triticun aestivum* (Wheat), *Hyoscyamus niger* (henbane), *Beta vulgaris* (sugarbeet) and *Spinacia oleracea* (spinach)

Wheat

Henbane

Sugar Beet

Spinach

Short day plants (Long night plants) / SDP

Flowering occurs when the day length exposure is less than the "certain critical length". The critical day length or the photoperiod is the limit below which they must flower.

Continuity of dark period is more important for flowering.Night break by a flash of red light (660nm) prevents flowering in SDP.

Pr form promotes flowering and Pfr form inhibits flowering in SDP.

e.g., Xanthium

Long day plants (short night plants)/ LDP

Flowering occurs when the day length exposure is greater than the "certain critical length". The critical day length or the photoperiod is the limit above which they must flower.

In LDP, continuity of dark period is not essential. Even a night break by a flash of red light (660nm) will cause flowering in LDP.

Pfr form leads to flowering in LDP.

e.g., Hyoscyamus

3. Day neutral plants

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

E.g. *Lycopersicum esculentum* (Tomato), cotton, sunflower and maize *Mirabilis jalapa*

Tomato

Cotton

Sunflower

Maize

4. 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. *Cestrum nocturnum, Bryophyllum daigremontianum, Kalanchoe spp.*

Cestrum nocturnum

5. 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. *Trifolium repens, Campanula medium, Echeveria harmsii.*

Echeveria harmsii

Biological significance of photoperiodism

1. Yield of plants (flowers, grains and fruits) can be increased by sowing and cultivating the plants according to their favourable photoperiods.

2. Vegetative crops (radish, carrot, sugarcane, etc.) can be kept in the vegetative phase for a longer period of time.

Sugarcane (a short day plant),can be kept vegetative by giving a flash of red light during dark period, . Flowering if allowed to occur causes a reduction of 10–20 per cent sugar content.

3. Winter dormancy and autumn leaf fall can be prevented by increasing light hours.

4. Long-day treatment increases stolon formation in strawberry.

Let's revise

Q.1 What is photoperiodism. Classify plants on the basis of their photoperiods.

Q.2 Explain critical night.

Q.3 What is critical photoperiod?

Q.4 Explain photoinductive cycle?

*Read phytochrome to understand its role in photoperiodism.