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**Course: Deg.-I (Subs.)**

**Topic: Photoperiodism**

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### **Photoperiodism:**

The plants in order to flower require a certain day length i.e., the relative length of day and night which is called as photoperiod. The response of plants to the photoperiod expressed in the form of flowering is called as photoperiodism.

The phenomenon of photoperiodism was first discovered by Garner and Allard (1920, 22) who observed that the Biloxi variety of Soyabeans (*Glycine max*) and 'Maryland Mammoth' variety of tobacco (*Nicotiana tabacum*) could be made to flower only when the daily exposure to the light was reduced below a certain critical duration and after many complex experiments concluded that 'the relative length of the day is a factor of the first importance in the growth and development of plants'. Depending upon the duration of the photoperiod, they classified plants into three categories.

#### **(1) 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. Some examples of these plants which are also known as long-night-plants are Maryland Mammoth variety of tobacco (*Nicotiana tabacum*) Biloxi variety of Soybeans (*Glycine max*), Cocklebur (*Xanthium pennsylvanicum*).

- In short day plants the dark period is critical and must be continuous. If this dark period is interrupted even with a brief exposure of red light (660-665 m $\mu$  wavelength), the short day plant will not flower (Fig. 18.1B).

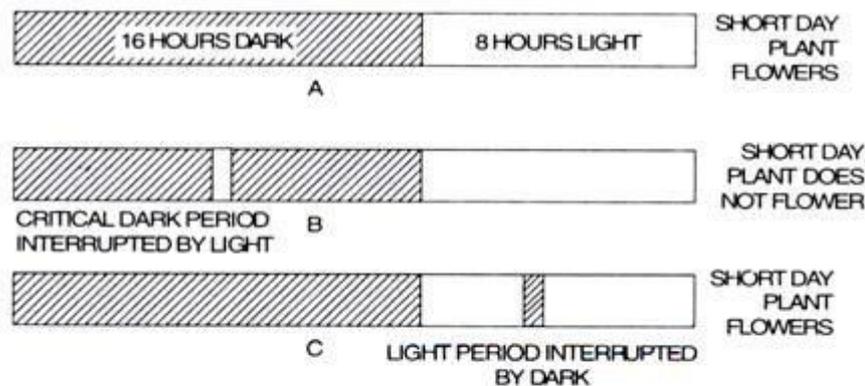


Fig. 18.1. Effect of a brief exposure of red light during dark and interruption of light period by dark on flowering in a short day plant.

- 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 m $\mu$  wavelengths).
- Interruption of the light period by dark does not have inhibitory effect on flowering in short day plants (Fig. 18.1 C).
- Prolongation of the continuous dark period initiates early flowering in short day plants.

## (2) Long Day Plants (LDP):

These plants require a longer day light period (usually 14-16 hours) in a 24 hours cycle for subsequent flowering. Some examples of these plants which are also called as short night plants are *Hyoscyamus niger* (Henbane), *Beta vulgaris* (Sugar beet) etc.

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

### **(3) Day Neutral Plants:**

These plants flower in all photoperiods ranging from 5 hours to 24 hours continuous exposure. Some of the examples of these plants are tomato, cotton, sunflower, cucumber and certain varieties of peas and tobacco.

During recent years certain intermediate categories of plants have also been recognised. They are,

#### **Long Short Day Plants:**

These are short day plants but must be exposed to long days during early periods of growth for subsequent flowering. Some of the examples of these plants are certain species of Bryophyllum.

#### **Short-Long Day Plants:**

These are long day plants but must be exposed to short days during early periods of growth for subsequent flowering. Some of the examples of these plants are certain varieties of wheat (*Triticum*) and rye (*Secale*).

#### **Photoperiodic Induction:**

Plants may require one or more inductive cycles for flowering. An appropriate photoperiod in 24 hours cycle constitutes one inductive cycle. If a plant which has received sufficient inductive cycles is subsequently placed under unfavourable photoperiods, it will still flower. Flowering will also occur if a plant receives inductive cycles after intervals of unfavorable photoperiods (i.e., discontinuous inductive cycles). This persistence of photoperiodic after effect is called as photoperiodic induction.

- An increase in the number of inductive cycles results in early flowering of the plant. For instance *Xanthium* (a short day plant) requires only one inductive cycle and normally flowers after about 64 days. It can be made to flower even after 13 days if it has received 4-8 inductive cycles. In such cases the number of flowers is also increased.
- Continuous inductive cycles promote early flowering than discontinuous inductive cycles.

Some of the example of plants which require more than one inductive cycles for subsequent flowering are *Biloxi soyabean* (SDP) —2 inductive cycles; *Salvia occidentalis* (SDP) — 17 inductive cycles; *Plantago lanceolata* (LDP)—25 inductive cycles.

### **Perception of the Photoperiodic Stimulus and Presence of a Floral Hormone:**

It is now well established that the photoperiodic stimulus is perceived by the leaves. As a result, a floral hormone is produced in the leaves which is then translocated to the apical tip, subsequently causing the initiation of floral primordia.

That the photoperiodic stimulus is perceived by the leaves can be shown by simple experiments on cocklebur (*Xanthium pennsylvanicum*), a short day plant. Cocklebur plant will flower if it has previously been kept under short-day conditions (Fig. 18.2 A). If the plant is defoliated and then kept under short day condition, it will not flower (Fig. 18.2 B). Flowering will also occur even if all the leaves of the plant except one leaf have been removed (Fig. 18.2 C).

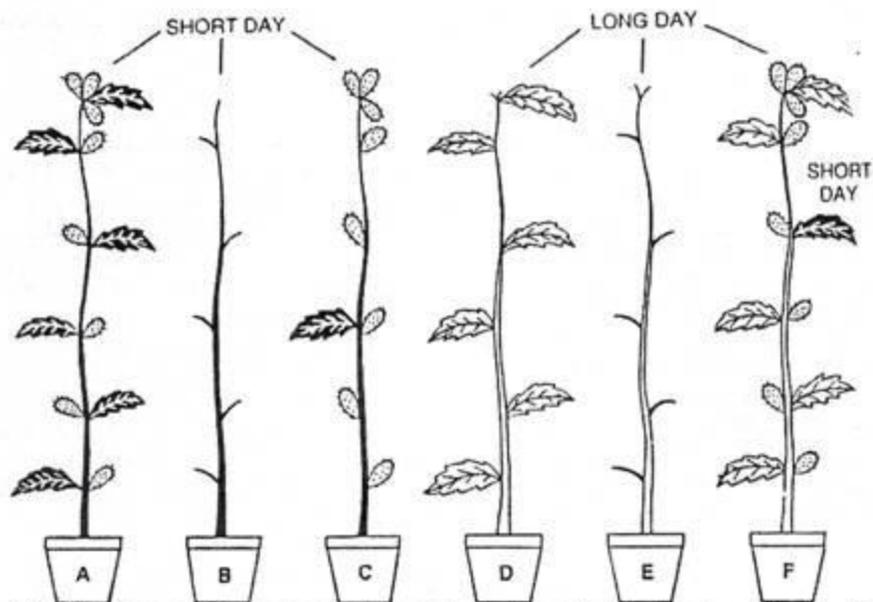
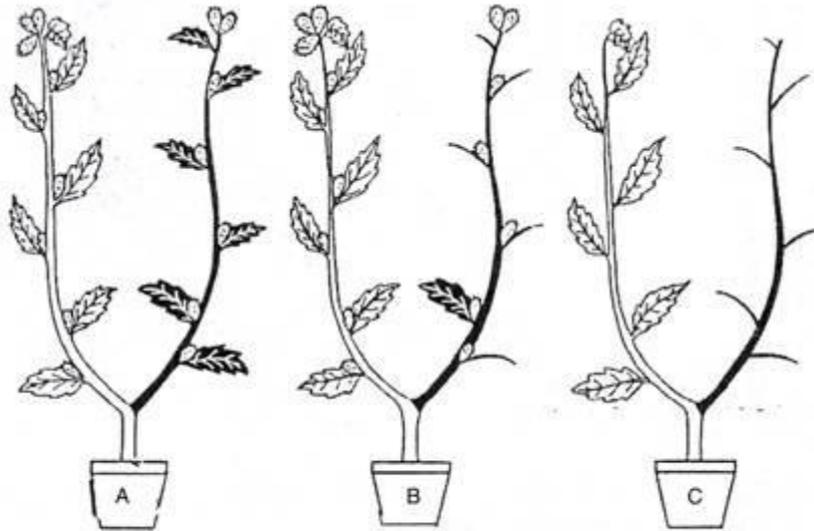


Fig. 18.2. Experiment on cocklebur plants to show that photoperiodic stimulus is perceived by the leaves. Flowering occurs even if a single leaf is exposed to appropriate photoperiod. See text

If a cocklebur plant whether intact or defoliated, is kept under long day conditions it will not flower (Fig. 18.2 D, E). But, if even one of its leaves is exposed to short day condition and the rest are under long day photoperiods, flowering will occur (Fig. 18.2 F).

The photoperiodic stimulus can be transmitted from one branch of the plant to another branch. For example, if in a two branched cocklebur plant one branch is exposed to short day and other to long day photoperiod, flowering occurs on both the branches (Fig. 18.3 A).

Flowering also occurs if one branch is kept under long day conditions and other branch from which all the leaves except one have been removed is exposed to short day condition (Fig. 18.3 B). However, if one branch is exposed to long photoperiod and the other has been defoliated under short day condition, flowering will not occur in any of the branches (Fig. 18.3 C).



**Fig. 18.3.** Experiments on cocklebur plants to show that the photoperiodic stimulus can be transmitted from one branch of the plant to another.

### **Nature of the Floral Hormone:**

Although there are firm evidences for the existence of a floral hormone but it has not yet been isolated. Therefore, the nature of this hormone which has been named as florigen is not very clear. But it is quite evident that this hormone is a material substance which can be translocated from leaves to the apical tips situated at other parts of the plant resulting in flowering.

Recent researches are indicative of ‘florigen’ to be a macromolecule unlike other plant growth hormones which are rather small molecules. This macromolecule may possibly be a RNA or protein molecule which is translocated from the leaf to the apical tips (or meristems) via phloem in photo-induced plants (Corbesier and Coupland, 2005).

Grafting experiments in cocklebur plants have even proved that the floral hormone can be translocated from one plant to another. For example, if one branched cocklebur plant (Fig. 18.4 A) which has been exposed to short day conditions is grafted to another cocklebur plant kept under long day conditions, flowering occurs on both the plants (Fig. 18.4 B).

Obviously the floral hormone has been transmitted to the receptor plant through graft union. But if a cocklebur plant is grafted to another similar plant both of which have been kept under long day conditions, flowering will not occur on either of the two plants (Fig. 18.4 C).

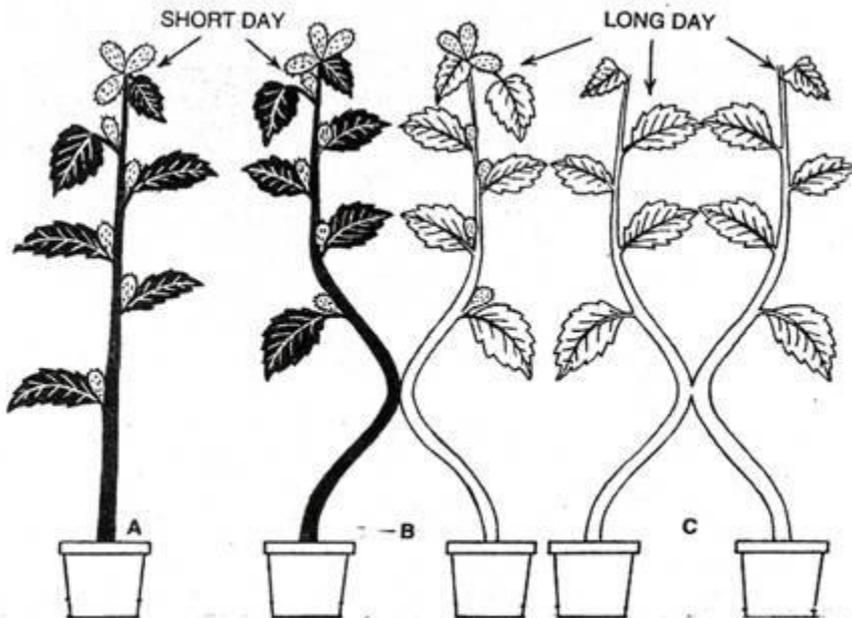


Fig. 18.4. Grafting experiments in cocklebur plants to show the translocation of floral hormone from one plant to another through graft union.

It has also been indicated that the floral hormone may be identical in short-day and long-day plants. For example, grafting experiments between certain long-day plants and short-day plants have shown that flowering occurs on both the plants even if one of them has been kept under non-inductive photoperiods.

(Continued in next lecture.....)

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