**Light**

Environmental factors that affect plant growth include light, temperature, water, humidity, and nutrition. It is important to understand how these factors affect plant growth and development. With a basic understanding of these factors, you may be able to manipulate plants to meet your needs, whether for increased leaf, flower, or fruit production. By recognizing the roles of these factors, you also will be better able to diagnose plant problems caused by environmental stress.

Three principal characteristics of light affect plant growth: quantity, quality, and duration.

A) Quantity

Light quantity refers to the intensity, or concentration, of sunlight. It varies with the seasons. The maximum amount of light is present in summer, and the minimum in winter. Up to a point, the more sunlight a plant receives, the greater its capacity for producing food via photosynthesis.

You can manipulate light quantity to achieve different plant growth patterns. Increase light by surrounding plants with reflective materials, a white background, or supplemental lights. Decrease it by shading plants with cheesecloth or woven shade cloths.

B) Quality

Light quality refers to the color (wavelength) of light. Sunlight supplies the complete range of wavelengths and can be broken up by a prism into bands of red, orange, yellow, green, blue, indigo, and violet.

Blue and red light, which plants absorb, have the greatest effect on plant growth. Blue light is responsible primarily for vegetative (leaf) growth. Red light, when combined with blue light, encourages flowering. Plants look green to us because they reflect, rather than absorb, green light.

Knowing which light source to use is important for manipulating plant growth. For example, fluorescent (cool white) light is high in the blue wavelength. It encourages leafy growth and is excellent for starting seedlings. Incandescent light is high in the red or orange range, but generally produces too much heat to be a valuable light source for plants. Fluorescent grow-lights attempt to imitate sunlight with a mixture of red and blue wavelengths, but they are costly and generally no better than regular fluorescent lights.

C) Duration

Duration, or photoperiod, refers to the amount of time a plant is exposed to light. Photoperiod controls flowering in many plants (Figure 26). Scientists initially thought the length of light period triggered flowering and other responses within plants. Thus, they describe plants as short-day or long-day, depending on what conditions they flower under. We now know that it is not the length of the light period, but rather the length of uninterrupted darkness, that is critical to floral development.

Plants are classified into three categories: short-day (long-night), long-day (short-night), or day-neutral, depending on their response to the duration of light or darkness. Short-day plants form flowers only when day length is less than about 12 hours. Many spring- and fall-flowering plants, such as chrysanthemum, poinsettia, and Christmas cactus, are in this category.

In contrast, long-day plants form flowers only when day length exceeds 12 hours. Most summer flowering plants (e.g., rudbeckia, California poppy, and aster), as well as many vegetables (beet, radish, lettuce, spinach, and potato), are in this category.

Day-neutral plants form flowers regardless of day length. Examples are tomato, corn, cucumber, and some strawberry cultivars. Some plants do not fit into any category, but may respond to combinations of day lengths. Petunias, for example, flower regardless of day length, but flower earlier and more profusely with long days.

You can easily manipulate photoperiod to stimulate flowering. For example, chrysanthemums normally flower in the short days of spring or fall, but you can get them to bloom in midsummer by covering them with a cloth that completely blocks out light for 12 hours each day. After several weeks of this treatment, the artificial dark period no longer is needed, and the plants will bloom as if it were spring or fall. This method also is used to make poinsettias flower in time for Christmas.

To bring a long-day plant into flower when day length is less than 12 hours, expose the plant to supplemental light. After a few weeks, flower buds will form.

Most leaves are sensitive to changes in light levels. If you take a plant that has been growing in the shade and place it in bright sunlight, it can get "sunburned." This is because plants growing in direct sun are smaller and develop a tougher epidermal layer, whereas plants growing in the shade need to optimize their ability to take in sunlight, and are, therefore, larger and have a thinner epidermis. These factors make them less well suited for situations with high light intensity. Some plants adapt to different light levels by modifying their new growth to suit the new environment. A plant may alter its leaf size and even color depending on light intensity and duration. For example, the common philodendron houseplant tends to produce smaller leaves on longer vines in dim light and larger leaves on shorter vines in bright light. On the other hand, a ficus tree brought from direct sun into dim light will shed some of its old leaves and begin to produce slightly larger, thinner leaves. Many variegated plants, such as crotons and coleus, will have more variegation in brighter light. Plants have also adopted different strategies to compete for light with those plants positioned around them. For example, the spring ephemerals that thrive on deciduous forest floors have leaves that emerge fully formed from rhizomes or bulbs. This enables them to complete their period of activity in sunlight before the forest trees overhead produce leaves. Among plants in a given environment, there is constant competition to position themselves in such a way that they receive light sufficient for growth.

The three main types of responses are

photoperiodism: the growth, development and other responses of plants and animals according to the length of day and/or night

photomorphogenesis: the regulatory effect of light on the growth, development and differentiation of plant cells, tissues and organs

phototropism: the movement of a plant toward or away from light

**Temperature**

Temperature influences most plant processes, including photosynthesis, transpiration, respiration, germination, and flowering. As temperature increases (up to a point), photosynthesis, transpiration, and respiration increase. When combined with day-length, temperature also affects the change from vegetative (leafy) to reproductive (flowering) growth. Depending on the situation and the specific plant, the effect of temperature can either speed up or slow down this transition.

a) Germination

The temperature required for germination varies by species. Generally, cool-season crops (e.g., spinach, radish, and lettuce) germinate best at 55° to 65°F, while warm-season crops (e.g., tomato, petunia, and lobelia) germinate best at 65° to 75°F.

b) Flowering

Sometimes horticulturists use temperature in combination with day length to manipulate flowering. For example, a Christmas cactus forms flowers as a result of short days and low temperatures (Figure 26). To encourage a Christmas cactus to bloom, place it in a room with more than 12 hours of darkness each day and a temperature of 50° to 55°F until flower buds form.

If temperatures are high and days are long, cool-season crops such as spinach will flower (bolt). However, if temperatures are too cool, fruit will not set on warm-season crops such as tomato.

c) Crop quality

Low temperatures reduce energy use and increase sugar storage. Thus, leaving crops such as ripe winter squash on the vine during cool, fall nights increases their sweetness.

Adverse temperatures, however, cause stunted growth and poor-quality vegetables. For example, high temperatures cause bitter lettuce.

d) Photosynthesis and respiration

Thermoperiod refers to daily temperature change. Plants grow best when daytime temperature is about 10 to 15 degrees higher than nighttime temperature. Under these conditions, plants photosynthesize (build up) and respire (break down) during optimum daytime temperatures and then curtail respiration at night. However, not all plants grow best under the same range between nighttime and daytime temperatures. For example, snapdragons grow best at nighttime temperatures of 55°F; poinsettias, at 62°F.

Temperatures higher than needed increase respiration, sometimes above the rate of photosynthesis. Thus, photosynthates are used faster than they are produced. For growth to occur, photosynthesis must be greater than respiration.

Daytime temperatures that are too low often produce poor growth by slowing down photosynthesis. The result is reduced yield (i.e., fruit or grain production).

e) Breaking dormancy

Some plants that grow in cold regions need a certain number of days of low temperature (dormancy). Knowing the period of low temperature required by a plant, if any, is essential in getting it to grow to its potential.

Peaches are a prime example; most varieties require 700 to 1,000 hours between 32° and 45°F before breaking their rest period and beginning growth. Lilies need 6 weeks of temperatures at or slightly below 33°F before blooming.

Daffodils can be forced to flower by storing the bulbs at 35° to 40°F in October. The cold temperature allows the bulbs to mature. When transferred to a greenhouse in midwinter, they begin to grow, and flowers are ready to cut in 3 to 4 weeks.

f) Hardiness

Plants are classified as hardy or nonhardy depending on their ability to withstand cold temperatures. Hardy plants are those that are adapted to the cold temperatures of their growing environment.

Woody plants in the temperate zone have very sophisticated means for sensing the progression from fall to winter. Decreasing day length and temperature trigger hormonal changes that cause leaves to stop photosynthesizing and to ship nutrients to twigs, buds, stems, and roots. An abscission layer forms where each petiole joins a stem, and the leaves eventually fall off. Changes within the trunk and stem tissues over a relatively short period of time "freeze-proof" the plant.

Winter injury to hardy plants generally occurs when temperatures drop too quickly in the fall before a plant has progressed to full dormancy. In other cases, a plant may break dormancy in mid- or late winter if the weather is unseasonably warm. If a sudden, severe cold snap follows the warm spell, otherwise hardy plants can be seriously damaged.

It is worth noting that the tops of hardy plants are much more cold-tolerant than the roots. Plants that normally are hardy to 10°F may be killed if they are in containers and the roots are exposed to 20°F.

Winter injury also may occur because of desiccation (drying out) of plant tissues. People often forget that plants need water even during winter. When the soil is frozen, water movement into a plant is severely restricted. On a windy winter day, broadleaf evergreens can become water-deficient in a few minutes, and the leaves or needles then turn brown. To minimize the risk of this type of injury, make sure your plants go into the winter well watered

**FIRE**

Fire is an interesting ecofactor. Fire is of a common occurrence in natural vegetation all over the world; it is more common in drier habitats than the wet. Lightening is the commonest natural cause of fire initiation. Our earth’s surface is hit by lightening every second in one or another part of the globe and many of these are of great magnitude. Other causes of fire are abrassive effects of falling rocks or of dried plant material such as bamboos, or spontaneous combination of very dry and hot material or by volcanic activities. Most forest fires are now man-caused, i.e., by incendiarists (such as poachers), debris burners, smokers, campers, short-circuiting of high-tension electric lines, and nearby railway lines. In the Meghalay region, tribals and even modern farmers practice the Jhum cultivation by periodically slashing the forest, burning them and raising crops on the ash enriched soil for a few years and moving to another segment of forest as the earlier one becomes eroded and nutrient deficient.

Types of FireFires are generally classified as (i) Ground fires which develop in such conditions where organic matter (litter) accumulates richly as heaps and they catch fire which generally smoulder for longer periods. Thus, in dry litter, fire is rapid and extinguishes quickly, while in somewhat moist litter, the fire is slow and with its heat the inner parts of litter-heap also get dried and fire continues for a longer period. Ground fires are flameless and subterranean and kill almost all herbaceous plants rooted in the burning material except some woody species (shrubs and trees). (ii) Surface fires which sweep over the ground surface rapidly and their flames consume the litter, living herbaceous vegetation and shrubs and also scorching the tree bases if comes in contact. (iii) Crown fires which are most destructive, burning the fores canopy and are common in dense woody vegetations. They spread in the top layers from the canopy of one tree to the canopy of another and so on. Canopy fires produce a temperature up to 704.5°C, killing the trees, shrubs and herbs. However, in moist soil surface, the underground plant parts and buried seeds escape death. Destructive crown fire in Yellowstone National Park during the summer of 1988. Wildlife that can't escape are killed and wildlife habitats are destroyed. SevereEffects of FireFire has direct (e.g., lethal) as well as indirect effects on plants and wild-life. Some well confirmed indirect effects of fire on plants are as follows :1. Fire causes injury to some plants, resulting large scars on their stems. Such scars may serve as suitable avenues of entry of parasitic fungi and insects.2. Fire arrests the course of succession and modify the edaphic environment very much.3. Fire brings about distinct changes of such ecofactors as light, rainfall, nutrient cycles, fertility of soil, litter and humus contents of soil, pH, water holding capacity and soil fauna (earthworms, nematodes, arthropods, etc.) Soil fungi are reduced while bacteria increase due to post-fire changes in the soil.4. Fire plays an important role in the removal of competition for surviving species. Fire tolerant plant species generally increase in abundance at the expense of those killed by fire (fire-sensitive plants) due to considerable reduction in competition and possibly due to alteration in other conditions.5. Some plants such as Populus tremuloides and Epilobium angustifolium are stimulated to growth by fires. A number of such grasses as Aristida stricta, Cynodon dactylon, Paspalum notatum, are stimulated by fire to produce large quantities of seeds. In some grasses and legumes, the seeds would germinate only after these get fire treatment (e.g., seeds of Themeda, Heteropogon, Andropogon, Rheus, Tephrosia and Stipa).6. Some fungi, mainly some ascomycetes, grow in soils of burnt areas. Such fungi are known as pyrophilous (e.g., Pyrophilous confluens).

7. The microclimate too is greatly changed due to addition of ash, loss of shade, loss of raindrop interception, accelerated erosion, etc.

Adaptations to FireIn frequent fire prone areas certain plants develop the following adaptations :1. Certain trees, particularly conifers such as Pinus and Larix and dicots such as Quercu develop fire resistant bark with insulating effect against heat. These trees also have tall trunk with the crown restricted to upper zone only. This helps in escaping the destructions against surface and ground fires.2. In some plants leaves are fire-resistant due to poor contents of such compounds such as resin or oil, and may check surface fires.3. Some plants as Pinus rigida and species of Eucalyptus have adventitious or latent axillary buds which may develop into new branches. Similarly Betula papyrifera and Vaccinium sp., may develop new shoots after fire kills the older ones.4. Epilobium anguistifolium acts as a fire indicator species. It grows in patches and in dormant condition. In case of fire, these plants rapidly grow while other plants die due to fire.

 **WIND**

The strong moving current of air is called wind. It is an important ecological factor of the atmosphere affecting variously the plant life on flat plains, along sea coasts and at high altitudes in mountains. Wind is directly involved in transpiration, in causing several types of mechanical damage and in dissemination of pollen, seeds and fruits. Wind also modifies the water relations and light conditions of a particular area. The movement or velocity of wind is affected by such factors such as temperature, atmospheric pressure, geographical features (including topography), vegetation masses and position with respect to sea shores. Air moves from a region of high pressure to low pressure. The pressure differences are mainly due to differential heating of atmosphere. The equatorial regions receive more heat than north or south regions, thus, low pressure occurs at lower latitude. The air generally moves from poles towards equator. Winds result in various physical, anatomical and physiological effect on plants:

1. Physical effects such as breakage and uprooting; deformation; lodging or flattening of herbaceous plants such as wheat, maize, sugarcane, etc.;

2. abrasion of buds of plants (by wind-carried soil particles), erosion and deposition of soil around plant roots; plant injury due to salt spray along sea coasts

 3. Anatomical and physiological effects such as formation of dense, reddish xylem called compression wood on the compressed side of wind deformation,

4. desiccation due to increased rates of evaporation and transpiration which are caused by strong winds and dwarfing of trees on sea coasts, arctic or alpine timberline due to prolonged dehydration and consequent loss of turgidity under the influence of drying winds.