ECOLOGICAL REQUIREMENTS OF HORTICULTURAL PLANTS

PLANT GROWTH AND DEVELOPMENT = GENETICAL STRUCTURE + ENVIRONMENTAL FACTORS

- Climate has a direct effect on yield and quality of horticultural plants. Simply, it consists of temperature, light, relative humidity and wind.

- Temperature
- Light
- Relative humidity
- Wind

TEMPERATURE

- The development temperature limits of most of the horticultural plants changes between 5 and 36 °C.
- Optimum temperature limit can change based on:
- a) Plant species and cultivars
- b) Development stage of plant
- Optimum temperature level change based on the species and cultivars and it mostly depends on the heritage of the plant.

- Temperature differences between day and night during growing period positively affects:
- a) Coloring in wine grapes and in some other fruit species such as apple.
- b) Development of seedling plants in vegetable species.

HEAT UNIT ACCUMULATION

- Temperature is a key factor for the timing of biological processes, and hence the growth and development of horticultural plants.
- Unit degree-day
- The amount of heat required to complete development of a horticultural plant does not vary; the combination of temperature (between thresholds) and time will always be the same.

- Threshold temperatures for calculation accumulated heat unit
- Grape 10°C Stone fruit 5°C
- Pome fruit 7°C Pistachio nut 12°C
- HOMEWORK: How can we calculate HEAT UNIT ACCUMULATION FOR A CERTAIN SPECIES??

LOW TEMPERATURES ARE THESE ALWAYS DANGEROUS???

- Vernalization-chilling requirement
- Are low temperatures always detrimental to the cultivation of horticultural species?
- Low temperatures are not always harmful. They also have positive effects on growth and development in plants. For example, in order to break the dormancy in seeds, the seed must be kept at low temperature for a certain period of time. This cooling requirement in seeds is called «vernalization» (4-10°C, 4-8 weeks). On the other hand, in perennial horticultural plants, the buds must be exposed to low temperatures for a certain period of time during the winter months for breaking the dormancy in the spring months. This is called chilling requirement in perennial horticultural species. This temperature limit varies between 0-7 °C for chilling requirement.

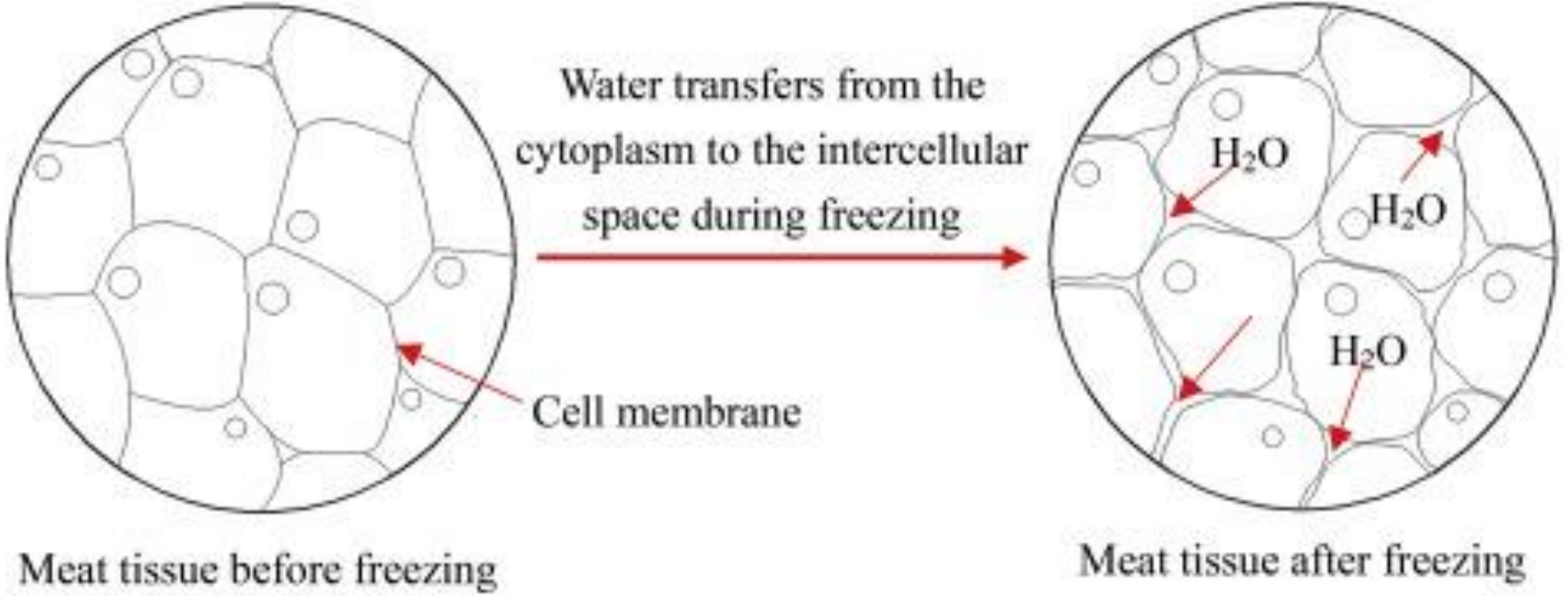
IF CHILLING REQUIREMENT IN PERENNIAL PLANTS IS NOT MET;

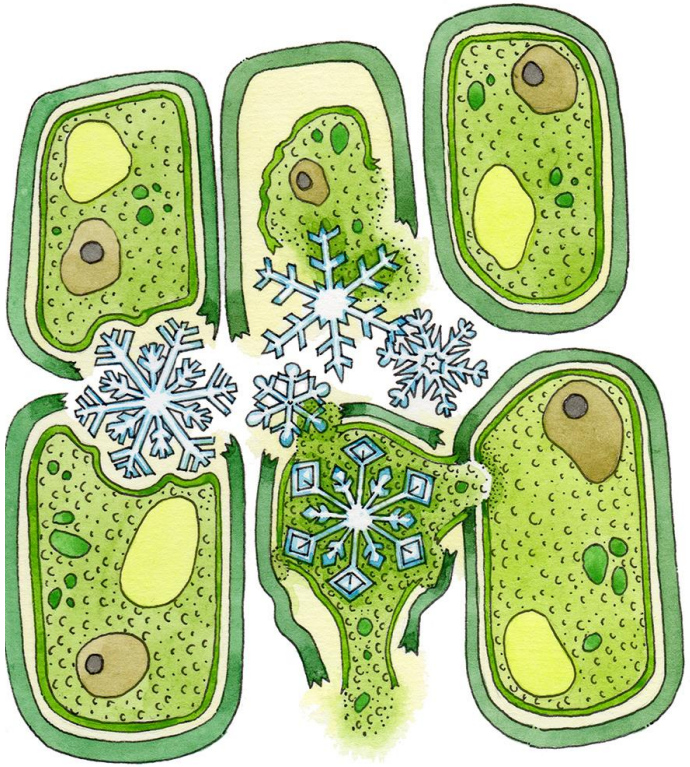
- Leafing is reduced
- Or no foliation at all,
- Bud shaking in stone fruit species
- Irregular flowering in pome fruit species
- Since the flowering period is prolonged, fertilization cannot occur completely, yield decreases.

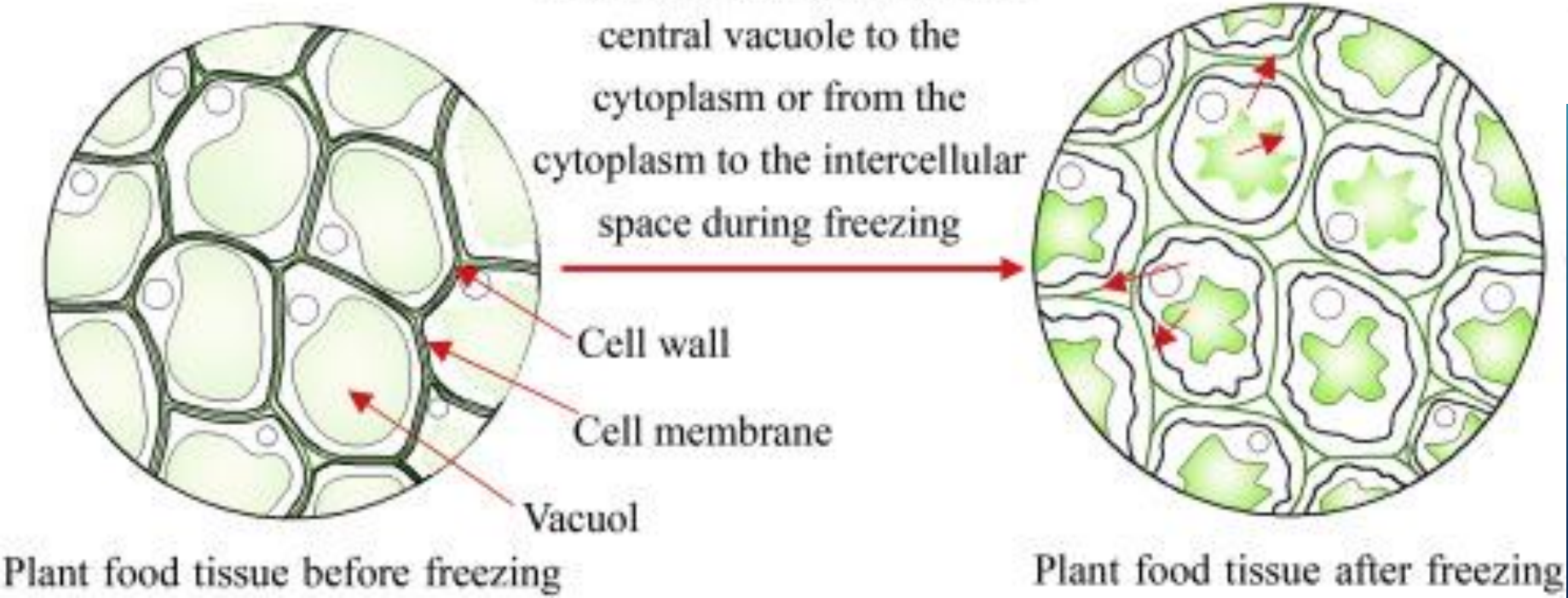
DETRIMENTAL EFFECTS OF LOW TEMPERATURES

- Low temperatures decrease the photosynthetic activity of plant.
- They can cause freezing-drought
- They negatively affects pollination and fertilization in horticultural plants.

Figure 1. Kale drooping and water soaked from freeze injury.


Water transfers from the cytoplasm to the intercellular space during freezing
Cell membrane
H_2O
H_2O
H_2O
Meat tissue before freezing
Meat tissue after freezing




Water transfers from the big central vacuole to the cytoplasm or from the cytoplasm to the intercellular space during freezing
Cell wall
Cell membrane
Vacuol
Plant food tissue before freezing
Plant food tissue after freezing

WHAT ARE THE FACTORS THAT DETERMINE LOW TEMPERATURE DAMAGE?

- **Herbal factors:**
- Morphological structure of the plant
- Anatomical structure of the plant
- Chemical structure of the plant
- **Environmental factors:**
- Degree and duration of low temperatures
- The decrease rate of temperature
- Plant's development stage and growth rate
- The ability of the plant to adapt to low temperature

IMPORTANT FEATURES OF PLANTS THAT ARE COLD RESISTANT:

- Resistant plants contain high levels of non-freezing bound water and water-soluble carbohydrates in their cells.
- There is less free water.
- Colloidally retained water has a lower freezing point.

LOW TEMPERATURES ARE DANGEREOUS IN:

- Winter
- Spring
- Autmn

LOW TEMPERATURES IN WINTER

- Banana at 0°C, lemon at -3.5°C can be damaged.
- Low winter temperatures can damage fruit trees, vineyards, and vegetables under protected cultivation.
- One year old shoots and buds can freze during winter at low temperatures.
- Moreover, low temperatures during winter period can cause mechanical damage in the roots.

TO PROTECT FROM THE WINTER COLD:

- Growing cold-resistant species and cultivars
- Giving importance to P and K fertilization
- Avoiding excessive and late N fertilization and irrigation
- Mulching on strawberries
- Covering newly established and low-stemmed vineyards with soil before winter

LATE SPRING FROSTS

- Temperatures often drop below 0°C after the start of shooting of buds and flowering during spring period.
- Early blooming almonds, apricots, plums and peaches are exposed to late spring frosts in the inner regions and transitional regions of Anatolia.

- **In all species, small fruits are more susceptible than flowers to late spring frosts**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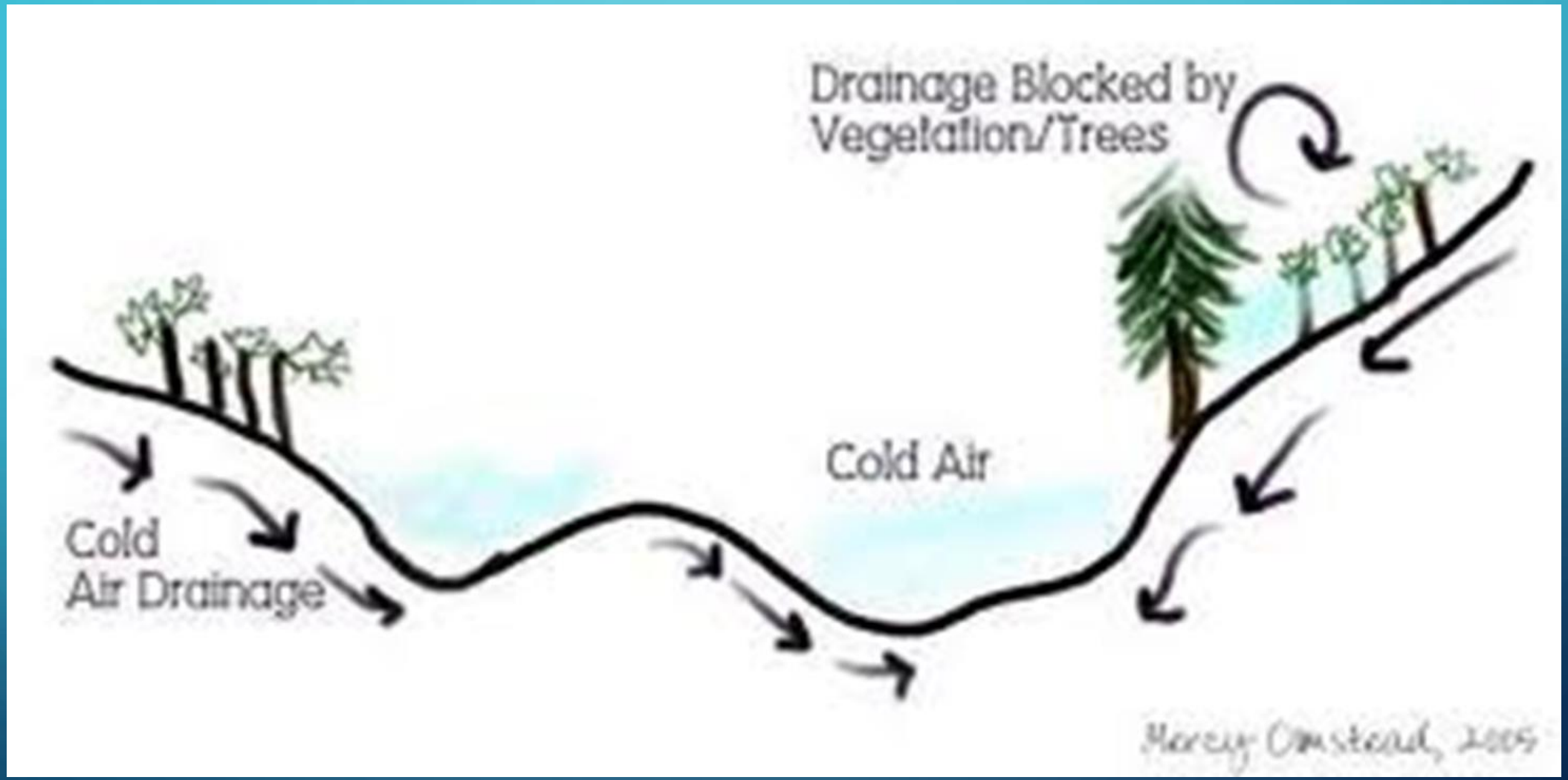

Drainage Blocked by
Vegetation/Trees
Cold Air
Cold
Air Drainage

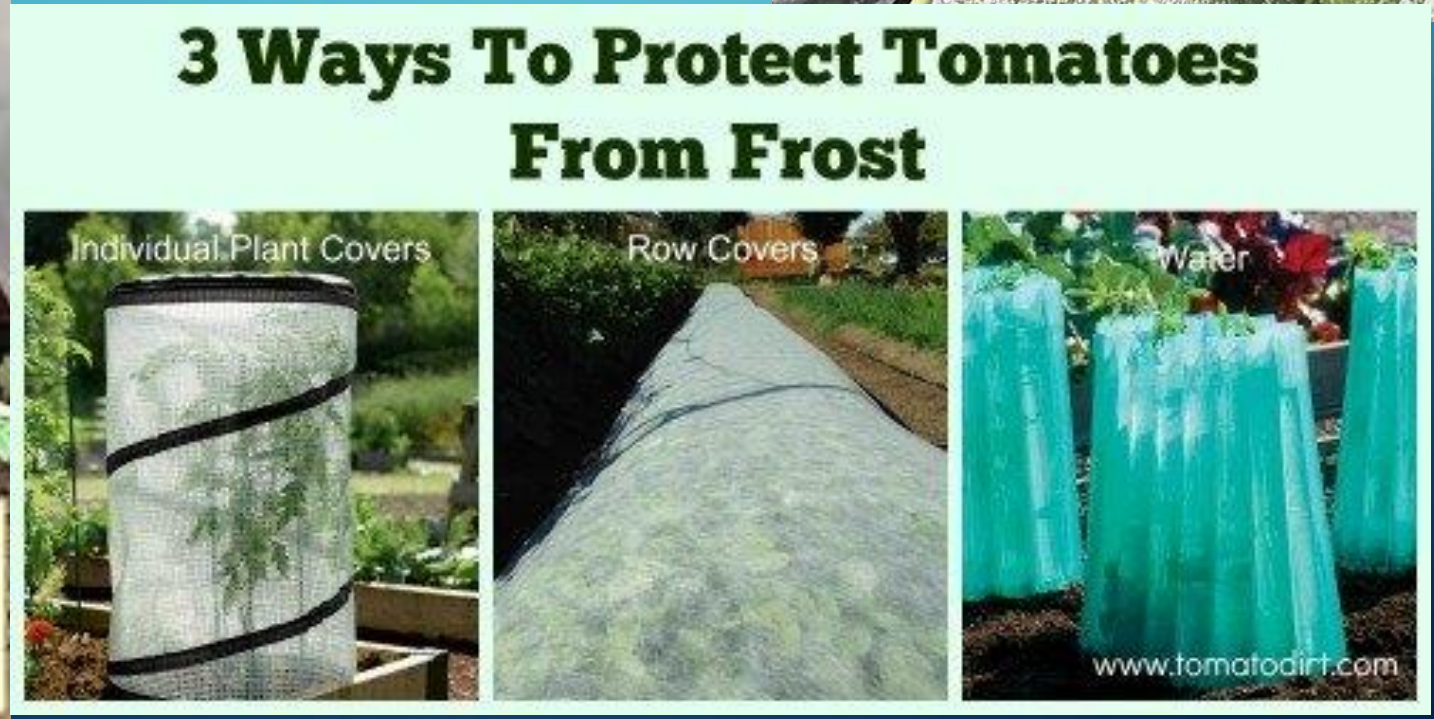
TO PROTECT FROM LATE SPRING FROSTS

- Cultivation of late blooming species and cultivars,
- Planting vineyards and fruit orchards on sloping lands instead of valleys and pits forming frost base.
- Establishment of fruit orchards andf vineyards on north-facing slopes
- Proper formation of rows to allow cold air to flow
- High crowning of trees
- Application of high training systems and late pruning in viticulture

- Making a fire and raising the air temperature with heaters
- Smoke and fogging
- Mixing air with fans
- Sprinkler irrigation
- Protected cultivation by polyethylene coverings for early developing period of seedling plants or vegetables.


Virgin
wines

FALL EARLY FROSTS



- Freezing of immature crops on the tree or plants (suc as tomatoes, cabbages, quinces etc.)
- Damage to shoots
- **Protecting from early fall frosts :**
- Growing of earlier cultivars
- Establishment of orchards and vineyards on sloping areas
- Applying high training systems in vineyards
- Applying a balanced irrigation and nitrogen fertilization.

EFFECT OF HIGH TEMPERATURES ON HORTICULTURAL PLANTS

- It causes disruption of the balance between photosynthesis and respiration in the plant.
- The growth of the plant slows down, if the plant cannot take the water it lost from the soil, yellowing, wilting and eventually death of the plant are seen.
- The damage is more severe when the plant is young.
- It negatively affects fruit set during flowering and fertilization.

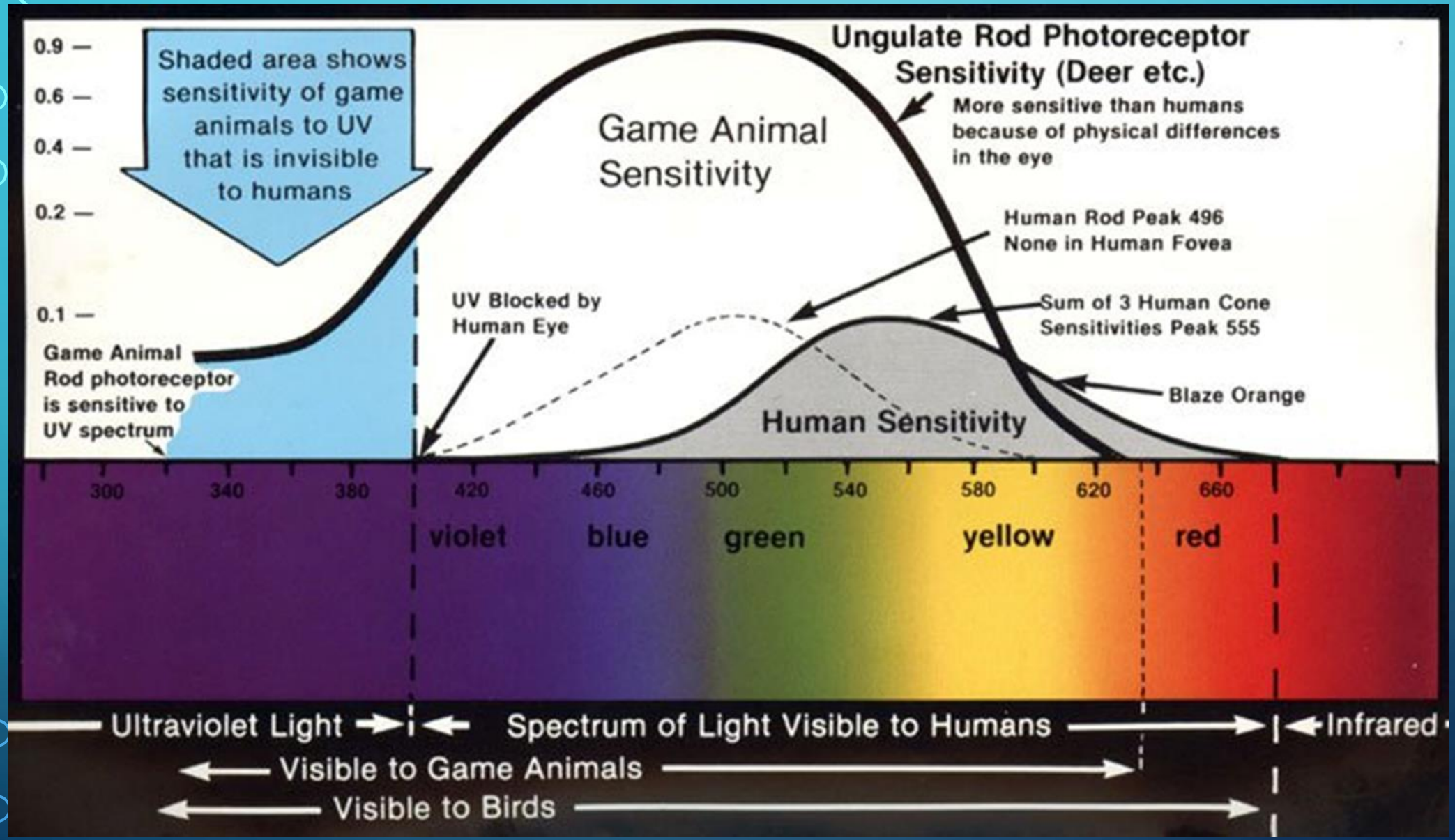
AT HIGH TEMPERATURES:

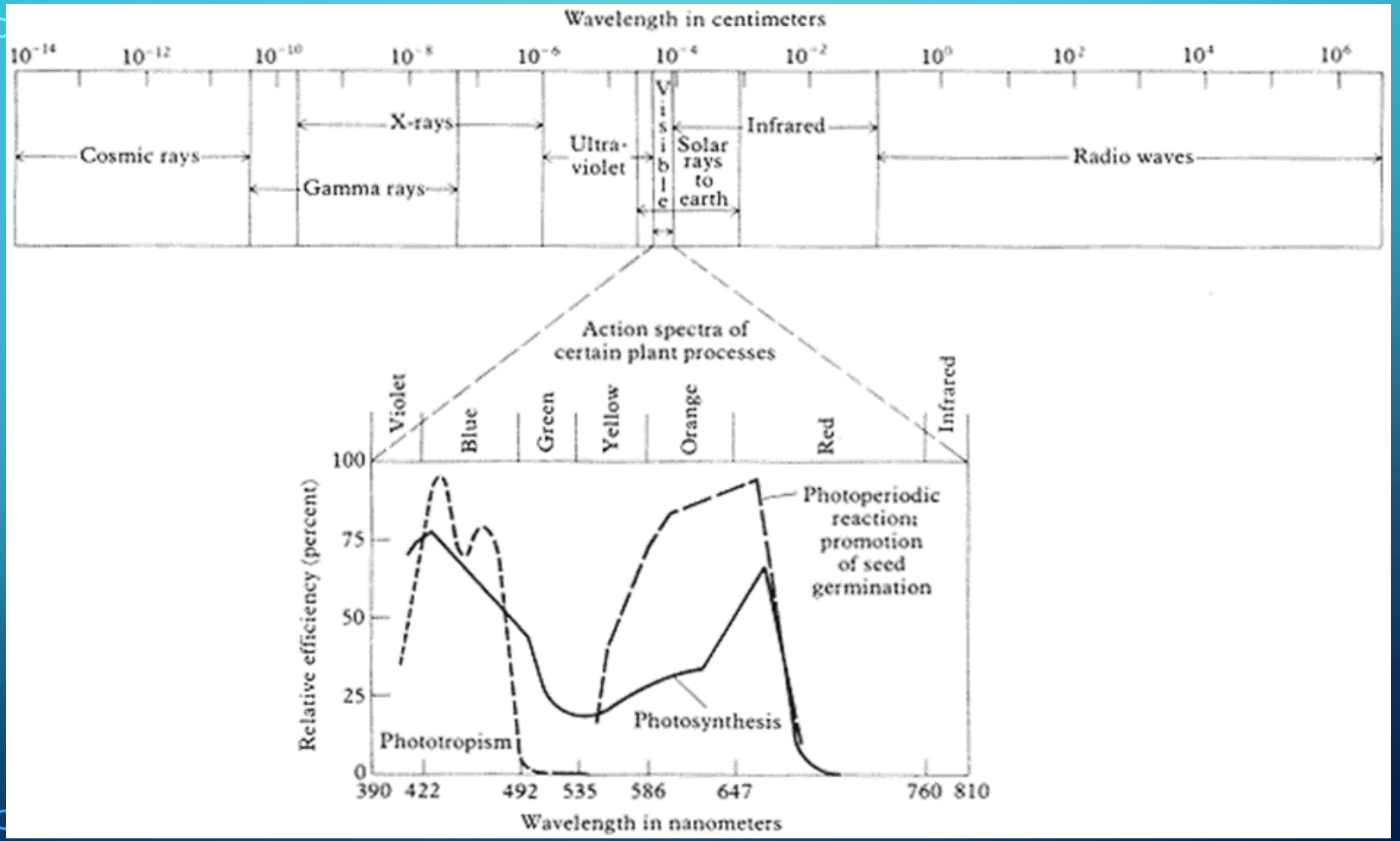
- During the ripening period, the fruit color becomes lighter,
- The fruit taste decreases,
- They cause yellowing and wilting of leaves in horticultural species whose leaves are consumed.
- Temperatures slightly above the optimum during ripening in some vegetables and fruits (melon, watermelon, peach and apricot) positively affect the formation of colour, taste and odour of fruit.

LIGHT

Visible wavelength rays (400-700 mu) of sunlight direct the basic physiological and biochemical events in plants, especially photosynthesis.

- Although ultraviolet rays are much more effective photochemically, they have harmful effects on horticultural plants.
- Under white and red light conditions, the buds grow easily, but in green light they do not.
- While ultraviolet rays with wavelengths (315-400 millimicrons) cause dwarfism in plants, thickening of leaves and feathering, rays with shorter wavelengths have lethal or genetic changes in the plant (mutation).

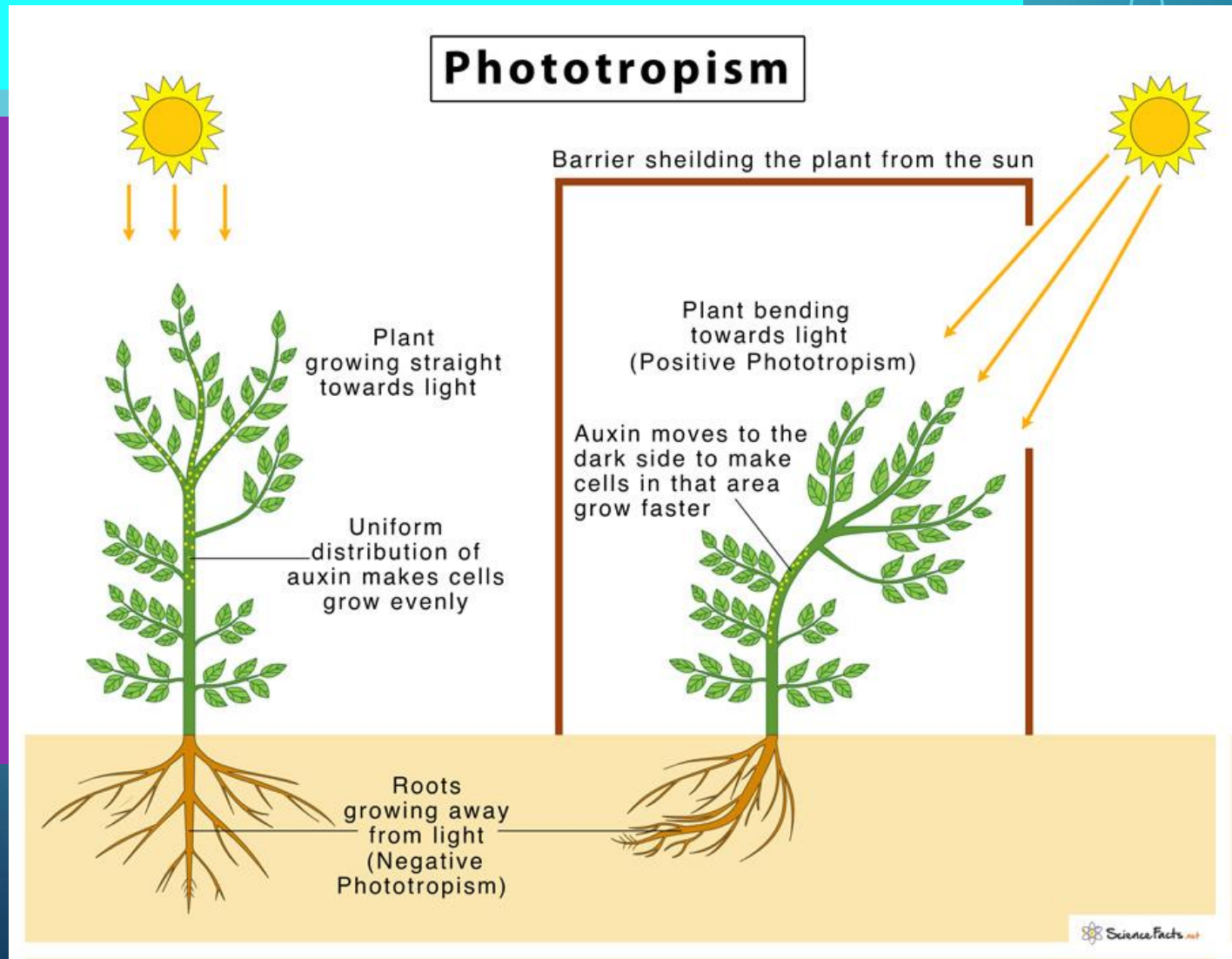

0.9
0.6
0.4
0.2
0.1
Shaded area shows sensitivity of game animals to UV that is invisible to humans
Game Animal Sensitivity
Ungulate Rod Photoreceptor Sensitivity (Deer etc.)
More sensitive than humans because of physical differences in the eye
Human Rod Peak 496
None in Human Fovea
UV Blocked by Human Eye
Sum of 3 Human Cone Sensitivities Peak 555
Blaze Orange
Game Animal Rod photoreceptor is sensitive to UV spectrum
Human Sensitivity
300
340
380
420
460
500
540
580
620
660
violet
blue
green
yellow
red
Ultraviolet Light
Spectrum of Light Visible to Humans
Infrared
Visible to Game Animals
Visible to Birds


Wavelength in centimeters
10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 10^{0} 10^{2} 10^{4} 10^{6}
Cosmic rays
Gamma rays
X-rays
Ultra-violet
Visible
Solar rays to earth
Infrared
Radio waves
Action spectra of certain plant processes
Violet
Blue
Green
Yellow
Orange
Red
Infrared
Relative efficiency (percent)
100
75
50
25
0
Photoperiodic reaction: promotion of seed germination
Photosynthesis
Phototropism
390 422 492 535 586 647 760 810
Wavelength in nanometers

FOR OPTIMUM GROWTH AND COLORING IN FRUIT OPTIMUM LIGHT CONDITIONS ARE NECESSARY

PHOTOTROPISM

- Phototropism is the ability of the plant to re-orient the shoot growth towards a direction of light source. Phototropism is important to plants as it enhances the ability of plants to optimize their photosynthetic capacity.



PHOTOPERIODISM: HOW DAY LENGTH AFFECTS PLANT GROWTH

- ***The physiological reaction and/or developmental responses of a plant to the relative lengths of daylight and darkness it experiences.***
- **Photoperiod:** The recurring cycle of uninterrupted light and dark periods a plant is exposed to; usually 24 hours, with varying ratios of uninterrupted light and dark periods.
- **Long-Day Plant (LD):** A long-day plant requires >12 hours of sunlight, or <12 hours of uninterrupted darkness, to produce a bloom or flower.
- **Short Day Plant (SD):** A short-day plant requires <12 hours of sunlight, or >12 hours of uninterrupted darkness, to produce a bloom or flower.
- **Day-Neutral Plant (DN):** Day-neutral plants do not initiate flowering based on photoperiods. Many of these types of plants instead flower after reaching a certain developmental stage or age, or in response to other environmental factors such as vernalization.

Species	Classification (Short, Long, Neutral)
Beets	Long
Brussels Sprouts	Neutral
Cabbage	Neutral
Carrots	Long
Corn	Neutral
Cucumber	Neutral
Fennel	Long
Kale	Neutral
Lettuce	Long
Pea	Neutral
Potatoes	Long
Radish	Long
Spinach	Long
Tomato	Neutral
Turnips	Long