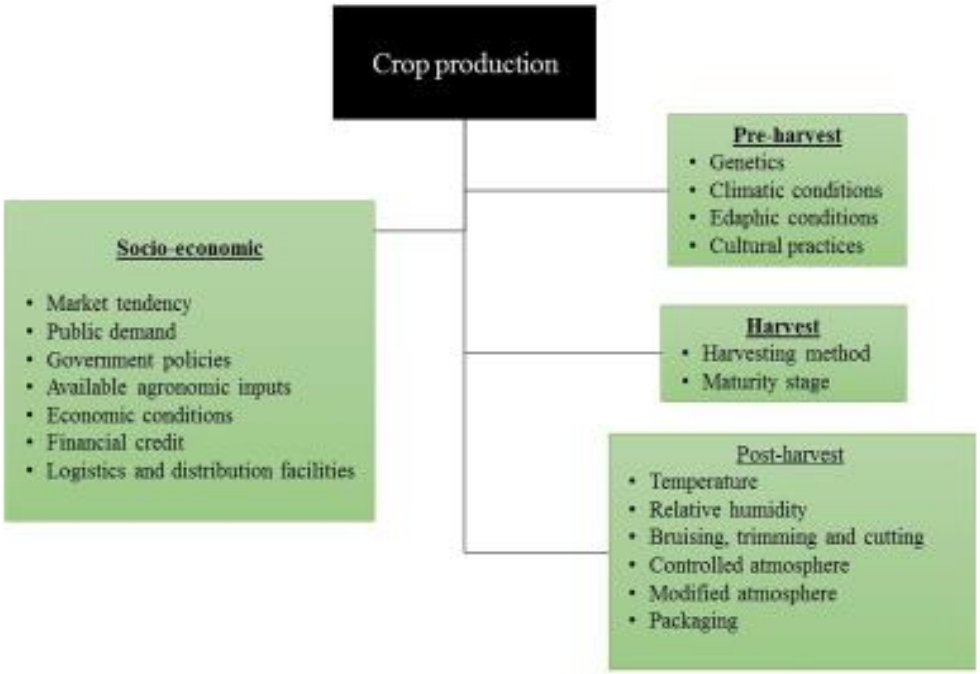
CLIMATIC FACTORS AFFECTING VEGETABLE GROWTH AND YIELD



INTRODUCTION

The climatic factors include rainfall and water, light, temperature, relative humidity, air, and wind. They are abiotic components, including topography and soil, of the environmental factors that influence plant growth and development.

Abiotic factors include the physical environmental conditions and biotic factors include animals, insects, and diseases. Each plant has certain environmental requirements. To attain the highest potential yields a crop must be grown in an environment that meets these requirements. A crop can be grown with minimal adjustments if it is well matched with its climate or growing condition. Unfavorable environmental conditions can produce a stress on plants resulting in lower yields. In such cases the environment can be artificially modified, such as in greenhouses, to meet the crop requirements.

A. TEMPERATURE:-

Of all the climatic factors, affecting vegetable production, temperature may be considered as the most important. Temperature affects growth & development of vegetable crops during different phases of growth such as seed germination, general survival, development of economic parts, flowering, pollination and fruit set, quality of produced, seed production, seed storage, seed dormancy, occurrence of diseases and pests. In this topic, low temperature is attained in high hills. Temperature is the most important factor which determines what crop to be grown in a certain place.

Temperature range	Crops
7 – 13^{0}C	Cabbage, potato, garlic, onion, spinach, peas etc.
13 – 18^{0}C	Sweet pepper, carrot, radish, tomato etc.
18 – 30^{0}C	Cucurbits, okra, cow pea, brinjal etc.

Chilling temperature or injury:-

Crops requiring high temperatures are very susceptible to chilling temperature i.e. 0 – 12^{0}C. Symptoms of chilling injury are the appearance of discolored area. Poor color development of depressed area on the surface of the leaf or fruits. Chilling injury is the result of interaction between the temperature and time of exposure.

Heat stress:-

emperature above 30^{0}C inhibit the germination of lettuce, celery and tuber formation in potato. The fruit set of solanaceous crops and legumes vegetables declines as the temperature exceeds 32^{0}C. In tomato, under heat stress condition, cracks at the stems ends may occur and the fruits become puffy. Onion and radish become more pungent at high temperature condition. At the temperature above 30^{0}C, the stomata remains closed. The symptoms of heat injury are the appearance of dead areas in young stems in legumes and the leaves of onion, cabbage and lettuce.

Vernalization:-

The biennial crops and some cool season vegetables such as onion, carrot, cabbage, cauliflower and spinach initiates flower formation after the exposure to the low temperature. The duration of vernalization to initiate flowering declines as the temperature decreases. E. g. at the same exposure duration, the radish flowers sooner at 5^{0}C than at 10^{0}C.

- Depending on the vernalization treatment vegetables are grouped into 3 classes
- Annuals: Vegetable species which do not have vernalization requirements for flower initiation, such crops produce flower and seed in the first year e.g.: Tropical radish and brassica chinensis
- Biennials: Biennial plants tend to remain in vegetative stage in the first year of growth and they flower and produce seed in the second year e.g.: beet, carrot, cabbage, biennial radish.

- Perennials : Perennial plants survive for several years producing flowers and seeds each year
- Most vegetables are however annuals and biennials.

Effect of temperature on:-

1. **Seed germination: –** Optimum temperature ranges for seed germination of warm season vegetables are 24 – 30^0C and optimum ranges of temperature for seed germination of cool season vegetables are 5 – 15^0 Most of the warm season vegetables crops so impaired germination at higher temperature beyond 30^0C.
2. **General survival: –** On the basis of temperature requirement, vegetables crops are classified as cool season and warm season crops. Cool season crops differ from warm season crops in the following respects.

Cool season crops:-

Hardy	Half hardy
Amaranthus, broad bean, broccoli, cabbage, Brussels sprouts, garlic, fenugreek, onion, parsley, peas, radish, rhubarb, spinach, turnip etc.	Beet, carrot, cauliflower, celery, chicory, endive, lettuce, parsnip, potato,

Warm season crops:-

Tender	Very tender
Cowpea, new Zealand spinach, soybean, Sweet corn, tomato, etc.	Cucumber, eggplant, musk melon, okra, hot pepper, pumpkin, squash, sweet potato, water melon, etc.

3. **Flowering: –** On the basis of temperature requirement of flowering, vegetable crops can be grouped as chilling requirement and non-chilling requirement crops.

Chilling requiring crops	Non-chilling requiring crops
Beet, Brussels sprout, cabbage, carrot, celery, Swiss chart, onion, leek, parsley, parsnip, etc.	All cucurbits, eggplant, sweet pepper, tomato, tropical radish, tropical cauliflower, tropical cabbage, tropical turnip, okra, peas, beans, Chinese cabbage, etc.

4. **Pollination and fruit set: –** For most of crops temperature determines pollination, pollen tube germination and percentage of fruit set. Generally, the optimum average monthly night temperature of tomatoes is 21 – 23^0C for pollination and fruit set. In higher or lower temperature blossom drop occurs post pollen germination and pollen tube growth.
5. **Quality of produced:-** The quality of produced is important for vegetable grower because vegetable produce under normal environmental condition are better in quality and better quality vegetables always fetch higher market prices.
6. **Colored development:-**

- Yellow and red pigment development in tomato is temperature dependent. Optimum temperature for color development is 10 – 30^0
- In carrot, the orange color is carotene and the optimum temperature for development is 15 – 22^0
- **Physiological disorder:-** In cauliflower, exposure of early cultivars to cool temperatures causes buttoning. Buttoning means formation of miniature curds. Very low temperatures of 1 – 20^0C can cause bolting.
- Higher temperatures cause loose and leafy curds in cauliflower.
- In radish, turnip and broad leaved mustard higher temperature causes bolting.

7. **Seed production: –** The temperature requirement of vegetable crops for seed production is differ from different crops. Most of the cool season crops require lower temperature during their early growth period and higher temperature during flowering, fruit setting and seed maturity.
8. **Seed storage: –** Viability of seed is the function of temperature and moisture content of the seed. If the moisture content of the seed is higher, the storage temperature will be low and vice-versa.
9. **Seed dormancy: –** Freshly harvested seeds of some vegetable crops are dormant and sometime higher temperature breaks the dormancy (they start germination).
10. **Occurrence of diseases and pests:**–

- For examples late of blight of potato and tomato becomes epidemic at fairly lower temperature condition. Bacterial wilt of tomato wilt occurs at higher temperatures condition.
- Insect population increases and becomes active in higher temperature conditions.

B. LIGHT:-

Light from the sun to the earth travel in the waves. The length of the waves is measured in nm (10^{-9}m). Light is an electromagnetic radiation which is a form of kinetic energy. It is an integral part of photosynthetic reaction in which it provides the energy for the combinations of CO_2 and water in the formation of first manufacture compound. Manipulation of light can be made by alternating the planting season, the performance of crop is influenced by three aspects of light.

Light quality: –

Photosynthesis uses light which is visible to human eye. This light ranges from violet with a wavelength 380nm – red with wavelength of 670nm. Light quality becomes important when plants are grown under critical light condition. In the predominance of ultraviolet wavelength, the plant will be dwarf. Predominance of red wavelength causes the plant to be long and thin. Red light (660nm) promotes germination while infrared light (730nm) inhibit the process.

Light intensity: –

The amount of brightness of light is referred as intensity. Light intensity changes with time of day, season, elevation and latitude. It is measured in terms of gm. cal/area/unit time. It varies from location to location, day to day and season to season. clouds, dust, fogs reduces the light intensity. The vegetable crops are divided into sun and shade loving plants. The sun loving plant requires high light intensity to maintain a high rate of photosynthesis. The shade plant requires low light intensity. The sun plants have a higher compensation point. It is the amount of light at which photosynthesis is equal to respiration.

Light level	vegetable
high	Cucurbits, brinjal, potato, tomato, sweet potato etc.
medium	Onion, carrot, lettuce and taro.
Low to all darkness	Ginger, mushroom and bamboo shoots.

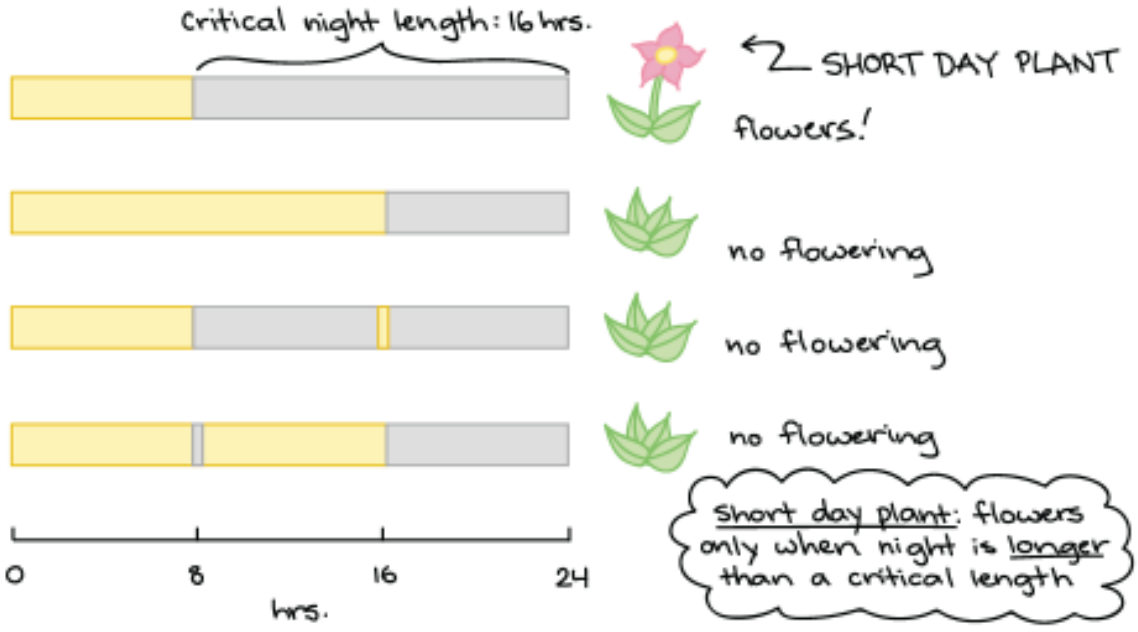
Light duration: –

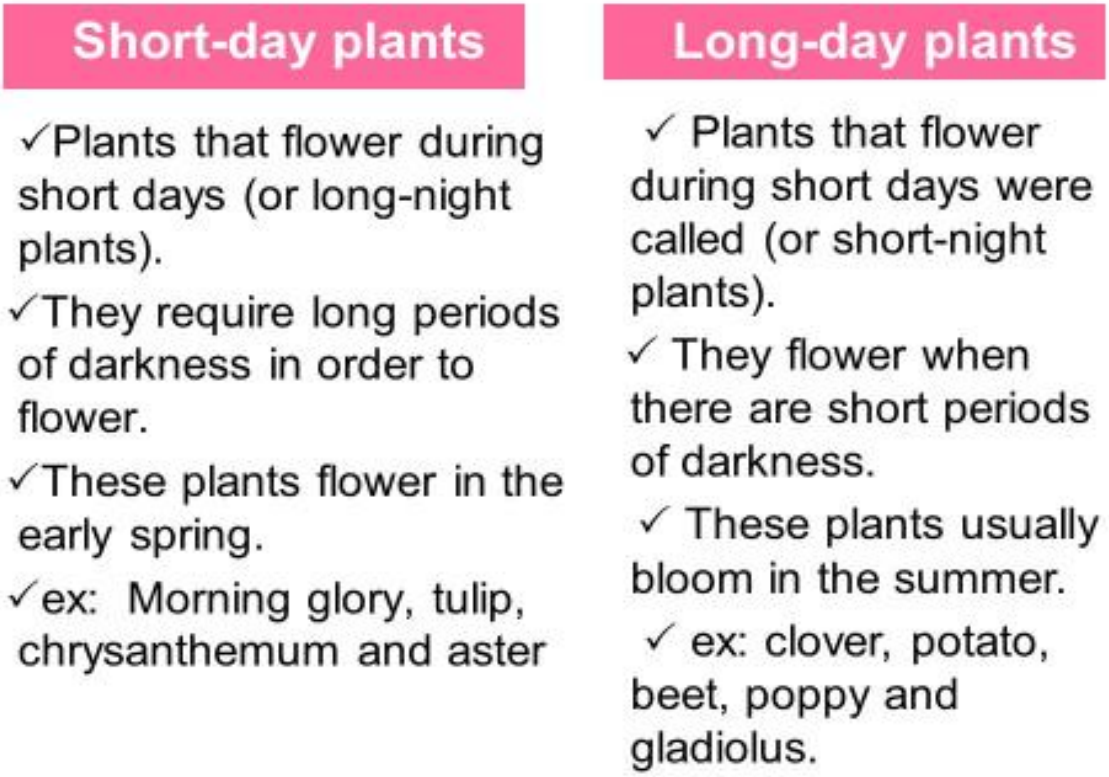
The duration of light is measured by the number of hours from sunrise to sunset. It is called photoperiod or day length. It varies from a nearly a uniform 12 hours day at the equator to the continuous light or darkness throughout the 24 hours for a particular part of the air at the polar region. In the tropics the differences between the shortest and the longest less than 3 hours. On the basis of response to light, the plants are classified into four groups:-

- **Short day plants** flowers rapidly when day become even shorter. They require short day of about 12 to 14 hours of continuous light for flowering. If short day plants are grown under long day condition, have abundant carbohydrates and protein resulting in vigorous growth and non-flowering. E.g. Some cultivars of cowpea, beans, sweet potato and some cultivar of potato and onion etc.
- **Long day plants** flower fast when the days are longer. They require long day of 14 to 16 hours of continuous light for flowering. E.g. beans, Chinese cabbage, lettuce, radish, spinach and some cultivars of potato, onion and cowpea.
- **Intermediate plants** require almost 12 hours of continuous light.
- **Day neutral plant** influence no light period for flowering. E.g. some varieties of bean and cowpea.

Photoperiodism

- **Photoperiodism** - length of day (night) directly related to onset of flowering
  - **Short-day Plants** - will not flower unless day length shorter than critical period
    - Asters, poinsettias, ragweed, sorghums, strawberries
  - **Long-day Plants** - will not flower unless periods of light longer than critical period
    - Beets, larkspur, lettuce, potatoes, spinach, wheat





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C. MOISTURE (RAINFALL AND HUMIDITY):-

Vegetables are composed of 80 – 90% of water and they have produced remaining 5 – 20% through photosynthesis. So water is one of the basic requirements for vegetable production. Both too much and too little moisture is harmful to vegetable crops and reduce yield. Moisture influences the seed germination, vegetative growth, flowering, fruit set, maturity, quality of vegetable, seed production, diseases and pest occurrence and seed viability in storage.

Water logging: – Under water logged condition, roots cannot uptake oxygen to maintain for nutrient and water uptake. Water logging causes death of root hairs, reduces absorption of nutrients and water, increases the formation of toxic compounds, retards growth of the plants and finally reduces the crop productivity. Flooding is more serious at high temperature conditions than at low temperature conditions. According to the sensitivity to flood, vegetables are divided into 3 groups: –

Sensitivity level	**Vegetable crops**
sensitive	Cole crops, beans, pumpkins, radish, tomato, water melon.
Moderately sensitive	Cucumber, brinjal, garlic, onion and peas.
Moderately tolerant	Sponge gourd, cowpea, sweet potato, Colacasia and water cress

Droughts:- When the water balance becomes negative, the stomatal opening decreases. The rate of photosynthesis and crop growth is also decreased. The effects of drought on determinate crops are greater than on the indeterminate crops.

D. HUMIDITY:-

Humidity plays the most important role in the occurrence of pests and diseases. Certain diseases like powdery mildew are associated with dry weather but humid condition is known to favor diseases like downy mildew and fungal blights affecting foliage. A cool humid place is ideal for growing cabbage, cauliflower, turnip, knolkhol, spinach, beet root, etc. especially for seed production. On the contrary, dry and higher temperature conditions are ideal for seed production for onion, broad leaved mustard, radish, cucumber, squash and pumpkin. In cucurbits, moist condition influences the onset of flowering significantly.

E. WIND:-

During rapid growth of plants, carbon dioxide is rapidly depleted on the root surface. A slight wind is essential for the supply of carbon dioxide near the plant surface. In strong wind, the average velocity greater than 7.2 km/hours are limiting factor of vegetable production.

F. SOIL:-

Generally sandy soil are best suitable for roots, bulb and tuber crops. Sandy soil is also preferred for early crops. Sandy soils allow fast development and easy harvesting of roots and tuber crops. Sandy soils cannot hold much water and nutrient. Loamy soils are ideal for vegetable production. They have good nutrient and water holding capacity. They provide good aeration to the root zone. Crops like onion, garlic, carrot, beet, radish, turnip, garden beet, potato, yams, sweet potato and tapioca do well in lighter soils. A heavier soil causes splitting of onion and malformed root.

Differences between determinate and indeterminate crops:-

Determinate crops	Indeterminate crops
1. These crops flowers in each node and terminal parts end into a flowering shoots.	1. They flowers after five leaves and the terminal part remains always vegetative.
2. They have discontinuous growth.	2. They have continuous growth.
3. They are very sensitive to drought condition.	3. They are drought tolerant crop.