

ABIOTIC FACTORS

Temperature, Moisture, Rainfall, Light,
Atmospheric pressure, Wind and Soil

a) Temperature

determines the duration of various stages in the insect life cycle and consequently the number of generations during any period of time

1. Directly on the **survival and development** which determine the abundance of a pest
2. Indirectly through **food and environmental factors** such as moisture, rainfall, wind etc.

1) Warm Blooded Animals (Homeothermic):

- maintain a **constant body temperature** within certain narrow limits
- Irrespective of the temperature variations in the external environment
- **'Endothermic animals'** -rely on internal source of heat to compensate the lost heat to cooler surroundings. Eg. Mammals

2) Cold Blooded Animals (Poikilothermic):

- not capable of maintaining constant body temperature
- They do not have internal mechanism of temperature regulation
- **'Ectothermic animals'** -depend upon the environment than the metabolic heat to raise their body temperature. Eg. Insects

3) Socio-homeothermic Animals:

- maintain body temperature **slightly above atmospheric temperature** and can air condition their nests
- **maintain their own temperature** inside their colony irrespective of the temperature outside
Eg. Honey bees

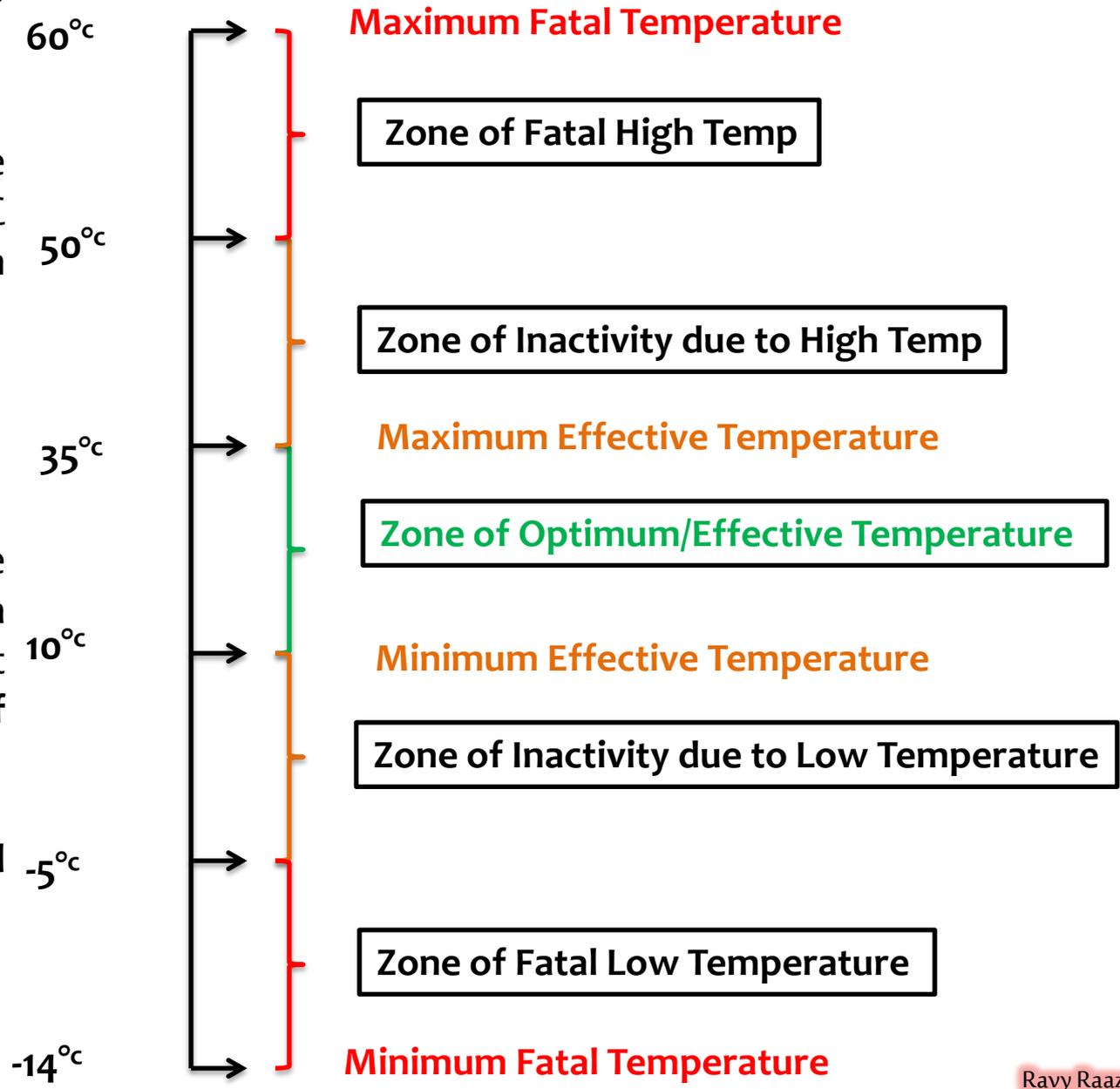
Temperature regulates the development, fecundity, feeding, movement, dispersal and distribution

'Zone Of Optimum or Normal Development' –opt. temp. for normal development is 10 to 35°C

Depending on the development of insects at different temperature levels, the temperature is divided into different zones

Some insects do not freeze but survive even under 0°C as their body fluids contain polyols like glycerols

If an insect is given a choice to move along a temperature gradient it prefers a narrow limit of temperature known as the 'Temperature preferendum' or 'Preferred temperature'



Zone of Fatal High (50 to 60)

Death at fatal high temperature is due to loss of water, coagulation of proteins, high metabolic rate, accumulation of toxins and affected enzymatic activity

Zone of Fatal Low (-5 to -14)

Death at fatal low temperature is due to low enzymatic activity, low metabolic rate and freezing of body fluids

Zone of Inactivity due to High Temp (30 to 50)

In these zones the insect is alive but no development and recovers with onset of favorable temperature

Zone of Inactivity due to Low Temp (10 to -5)

Zone of Optimum Effective Temp (10 to 35)

Normal growth and development takes place

Maximum Effective Temp (35)

Upper vital limit at which on ascending scale the development ceases and on descending scale the development begins

Minimum Effective Temp (10)

Lower vital limit at which on descending scale development ceases on ascending scale the development starts

Thermal constant:

Total heat energy required to complete a stage of development in life cycle or a physiological process of a species is constant i.e. **thermal constant** and measured in **Day - Degrees**

- 1) **Hibernation:** period of suspended activity occurring during seasonal low temperature
- 2) **Aestivation:** period of suspended activity during seasonal high temperature or in dry weather

Fecundity:

will be maximum at **moderately high temperatures** and declines at upper and lower limits of favourable temperature

Aphids remain parthenogenetic under high temperature and many hours of sunshine while the opposite condition give rise to oviparous forms

Adaptations to temperature:

At **high temperature**, **locusts** expose minimum body surfaces to sun's rays by **lying parallel** to them while they expose maximum body surface to sun's rays at **low temperature lying at right angle** to them.

Distribution:

Tropical and subtropical conditions as in India are ideal for the distribution and establishment of insects

Mediterranean fruit fly, *Ceratitis caipata* Wiedemann could not establish in England and North Europe since **its immature stages cannot stand below 10°C**

Mosquitoes are more abundant at **70 to 80°F** but are rare at **112 to 113°F**

Pink boll worm of cotton, *Pectinophora gossypiella* (Saunders) is serious in **Punjab** where the temperature is within **95.5°F** in August and September and not present in **West Pakistan** due to high temperatures at that period (**99° F**)

Dispersal and Movement:

Insects try to move away from unfavorable temperatures

The **rice weevil, *Sitophilus oryzae***(Linnaeus)- found in the **upper layers of bins** irrespective of whether the initial infestation started at the depth of the bin or at surface **due to rise in temperatures** i.e. when the temperature reaches **32°C**, the adults migrate to cooler upper layer.

Mass flight of **desert locust, *Schistocerca gregaria*** (Forsk.) or migration starts at **17 to 22°C** and they do not migrate when temperature is in between **14 to 16°C**

b) Moisture

- Insect body consists of **80 to 90** per cent water
- Aquatic larvae -**98** per cent ; **Storage pests- 50** per cent
- Water is generally lost through **spiracles and integument**

Adaptations to conserve moisture:

1. Body pigments:

- **Dark pigment** in cooler areas- **absorb more heat from sun** for raising body temperature
- **Light colour** in desert - **reflect sun's rays** and avoid excessive evaporation

2. Integument:

- **Well developed integument and fused sclerites**- beetles & weevils conserve moisture
- **Waxy coating** of integument also saves from excessive evaporation



3. **Winglessness:** Grasshoppers and crickets in arid regions- poorly winged/wingless-the **area of evaporation is reduced**



4. **Pilocity:** Dense hairs on the body prevent evaporation



5. **Form of body:**



Oval and compressed body of some desert beetles protects them from hot winds

- **burrowing habit** of desert insects- go into deeper layers when moisture is not available

6. **Reabsorption of water** from products of excretion

7. Some insects like *Amsacta* spp. enter into **aestivation** when dry conditions prevail

- The **fall of water content of body** below a certain minimum- **Death**
- **Above the normal** (wet places)- **disease** outbreaks

c) Humidity:

- There are **no definite ranges** of favorable humidity to all insects
- Humidity effects the speed of development, fecundity, colour etc.
- If water content of the body is high, **dry air** accelerates the development
- Locusts sexually mature quicker and no.of eggs laid are more at **70% R.H**
- Rhinoceros beetle develops **dark chitin in moist air and light chitin in dry air**
- Extremely **high humidity** conditions favors the **spread of diseases** in insects



d) Rainfall:

Total amount of rainfall distribution in time influences the abundance of insects in an area

- **More than 12.5 cm** rain during May-June, **cutworms** are forced to come out of the soil and fall prey to their parasites and predators
- **Less than 10 to 12.5 cm** rain, remain protected in soil and **outbreak as pest** in next season
- Hence, with **the number of wet days (0.8 cm)**, the outbreak of pest can be forecasted
- **Less than 10 wet days-increase** of cutworms in the following year
- **More than 10 wet days- decrease** in cutworm population
- In insufficient soil moisture, **Desert locust** doesn't lay eggs and even if, does not hatch
- Rainfall also plays an important role in **movement of swarms of desert locust**
- Moisture saturation is injurious for development of **spotted boll worm Earias fabia**
- **Red pumpkin beetle Aulacophora foveicollis** withholds eggs until it find moist soil
- Rain induces **emergence of most of the insects from soil**

Eg: Ants, termites, red hairy caterpillar, root grub beetles etc., emerge out from the soil after the receipt of rains