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Adoption of microclimate modification techniques

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Microclimate

Microclimate deals with the climatic features peculiar to small areas and with the physical processes that take place in the layer of air very near to the ground. Soil-ground conditions, character of vegetation cover, aspect of slopes, and state of the soil surface, relief forms – all these may create special local conditions of temperature, humidity, wind and radiation in the layer of air near the ground which differ sharply from general climatic conditions. One of the most important tasks of agricultural meteorology is to study the properties of air near the ground and surface layer of soil, which falls under the micro climate.

Micro climatic modification

Microclimate modification patterns are about the mimicking of natural systems to control the environment to achieve several benefits. Artificial control of field environment to keep the optimum condition of plant growth and crop production that is practice of environmental control requires a complete knowledge of physiology of plants and physical environment. It is done through:

- **Controlling wind velocity**
- **Controlling heat load**
- **Controlling water balance**

Plant Microclimate

The physical processes of the atmosphere, called meteorological processes, establish the existing climate or microclimate. Although it does not act alone, climate, in turn, determines the regime of soils and plants at a given location. Wind, precipitation, sunshine, temperature, humidity, and soil moisture are the primary factors involved. The profitable production of crops and efficient use of water require a microclimate suitable for plant growth.

There are five main factors that affect microclimates:

- **Topography**

  The shape of the land is a significant influence on microclimates. While on a large scale, weather systems have a certain predictability (related to the rotation of the earth and the interplay between ocean and land), these patterns can get disrupted at the local level by topographical features such as aspect and slope.

- **Aspect**

  It refers to the direction that a slope faces. This will determine how much solar radiation it receives, which in turn impacts upon temperature and shading. In the northern hemisphere south-facing slopes are exposed to more direct sunlight than opposite slopes, as are north-facing slopes in the southern hemisphere. This will cast longer shadows on the opposite side of the slope, which must be taken into account when deciding which species of plant to place there.

  The angle of slope on a geological feature is a major factor in determining the influence of wind and water on a site. The appropriate placement of windbreaks can help to alleviate these effects, while if you do have steep slopes on your site that create a lot of wind, you may wish to investigate harnessing this energy with turbines.

- **Soil**

  The composition of the soil affects microclimates primarily through how much water it retains or which evaporates from it. A soil that has a large proportion of **clay retains more moisture** than one that is predominantly sand. The degree to which a soil retains moisture affects the humidity and temperature of the air above it.

- **Water**

  It is not just the moisture level within the soil that can affect a microclimate, the water stored on the surface of the land is also important. Over a region, the presence of lakes and reservoirs can create a more moderate climate, while ponds, streams and other bodies of water will impact upon the temperature of the surrounding areas. These effects are due to the fact that water gains and losses heat more slowly than the land.

- **Vegetation**

  The vegetation on a site interacts with the soil and water to affect the microclimate. Not only does it cover the soil and prevent heat loss and radiation from it, it also regulates the temperature of the soil, filters dust and other particles from the air, and can act as a windbreak or suntrap.

- **Artificial Structures**

  Our house can impact upon microclimates by absorbing heat during the day and releasing it at night, by deflecting wind and creating sheltered spots, and reflecting sunlight.

Modification Techiques

Modification for wind

Windbreaks and shelterbelts provide the protective shelter against desiccating winds to extent of 5-10 times the height of the tall tree on windward side and up to 30 times on leeward side. For example a 10-11 meter tall windbreak when encountered by 45-50 km /hr wind, it reduces on windward side to 20-30 km /hr and to 10 km / hr on just leeward side.

- ✓ **Windbreak:** Windbreaks are such structures which break the wind-flow and reduce wind speed. A wide range of materials was used for windbreaks, including rigid bark sheets inserted in sand, piles of grass or foliage, and stone walls.

- To protect field crops / livestock from cold / hot wind.
- To prevent soil erosion.
- To reduce evaporation from farmlands.
- To improve the microclimate.
- For fencing and boundary demarcation.
- For productive role-fuel, fodder, etc.

Selterbelt: These are belts / blocks consisting of several rows of trees or shrubs planted for protection of crop against wind.

- To deflects air currents.

- To reduces the velocity of winds.
- To provides general protection to the leeward areas against the effects of wind erosion.
- To protects the leeward areas from desiccating effects of hot wind.
- To provide fuel, fodder timber etc.

Modification for heat load

During summer season in the tropical and sub-tropical areas, heat load on plants exceeds the tolerance limit. As a result of accumulation of heat energy, the soil temperature increases. The control of heat balance is achieved in two ways; one through heat trapping and by heat evading.

✓ **Heat Evasion**

In many areas in the tropics and subtropics, when the head load exceeds the tolerance limit, it is desirable to evade the thermal energy in order to achieve good result. In these areas shading of plants is common method of evading solar radiation. A number of shade structures are used and these are opaque. The shade can be wood or fibre.

✓ **Heat Trapping**

The opposite of heat evasion, heat tapping is extremely beneficial in temperate climates where the growing period is comparatively short. It can be achieved by:

- Taking into account the angle of solar radiation relative to plant
- Planting on steep and sunny slope
- Erecting alternate rows of alternate stone wall

Modification for frost

Frost damage to crops results not from cold temperature but mainly from extracellular (i.e. not inside the cells) ice formation inside plant tissue, which draws water out and dehydrates the cells and causes injury to the cells. The characteristics of frost/freeze protection methods are given below;

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	Advantages	Disadvantages	Comments
Site Selection	Preventive measure—choose location with good cold air drainage.		Best method of frost protection; visualize air flow and/or monitor minimum temperatures.
Heaters	Radiant heat helpful in freeze; installation costs lower than irrigation; allows delay; no risk if rate not adequate.	Fuel oil expensive.	Free-standing or pipeline; free-standing heaters need no power source.
Irrigation	Operational cost lower than heaters; can be used for other cultural purposes such as drought prevention.	Installation costs relatively high; risk damage to crop if rate inadequate; ice buildup may cause limbs to break; overwatering can waterlog soils; does not provide protection in wind above 5 mph.	Plant part protected by heat of fusion; fixed rate design delivers more protection than generally necessary; irrigation must continue until melting begins; backup power source essential.
Wind machines	Can cover 10-acre area if flat and round; installation cost similar to heaters.	Not effective in wind above 5 mph or advective freeze.	Mixes warm air near top of inversion down to crop height; may be used with heaters; may use helicopters.
Fog	Blocks outgoing radiant heat and slows cooling.	Has potential but is not currently practical.	Uses greenhouse effect to trap heat in crop canopy and limit radiation cooling.

Modification for water balance

During summer season the atmospheric water demand increases, resulting in high evapotranspiration (evaporation from wet soil surface and transpiration from crop canopy). Thereby rate of depletion of soil moisture increases. The water loss by this way is reduced by mulching and use of different types of antitranspirants.

- ✓ **ANTI-TRANSPIRANT:** Anti-transpirants are the materials or chemicals which decrease the water loss from plant leaves by reducing the size and number of stomata. Nearly 99 per cent of the water absorbed by the plant is lost in transpiration. Anti-ranspirants and any natural sustance applied to transpiring plant surfaces for reducing water loss from the plant. There are of **four** types:

- ➢ **Stomatal closing type:** Most of the Transpiration occur through the stomata on the leaf surface. Some fungicides like phenyl mercuric acetate (PMA) and herbicides like Atrazine in low concentration serve as antitranspirants by inducing stomatal closing.

- **2. Film forming type:** Plastic and waxy material which form a thin film on the leaf surface and result into physical barrier.

  Example: ethyl alcohol.

- **Reflectance type:** They are white materials which form a coating on the leaves and increase the leaf reflectance (albedo). By reflecting the radiation, vapour pressure gradient and thus reduce transpiration.

  Example: Application of 5 percent kaolin spray reduces transpiration losses. eg. Diatomaceous earth product (Celite), hydrated lime, calcium carbonate, magnesium carbonate, zincs sulphate etc.

- **Growth retardant:** These chemicals reduce shoot growth and increase root growth and thus enable the plants to resist drought. They may also induce stomatal closure. **Example:** Cycocel is useful for improving water status of the plant.

- ✓ **MULCHING:** The application or creation of any soil cover that constitutes a barrier to the transfer of heat or vapour known as mulching. It is the practice of placing a heat or moisture barrier over the top of the soil surface to check evaporation and to improve soil moisture conditions.

Types of Mulches:

- **Plastic mulch:**

  Plastic material like polyethylene and polyvinyl chloride are used as mulching materials.

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- **Stubble/Trash mulch:**

  It is created by permitting residues of small grain crops to remain standing in the field so as to increase surface roughness and reduce soil blowing. Crop residues like wheat straw or cotton stalks are left on the soil surface as stubble mulch. This type of mulch protects the soil from erosion and evaporation losses are reduced.

- **Soil mulch:**

  If the surface of the soil is loosened, it acts as mulch for reducing evaporation. The loose surface soil is called soil mulch. Intercultivation creates soil mulch in a growing crop. This mulch interrupts the continuity of capillaries and hence creates a barrier to the vapor.

- **Vertical mulching:**

  Sub-soiling is the most effective method of breaking hard pans to improve root penetration, aeration and water percolation. The effects of sub-soiling are not long lasting. The object of vertical mulching is to fill slots with organic matter and keeping them open and functional for a longer period.

Conclusion

Artificial control of field environment to keep the optimum condition of plant growth and crop production that is practice of environmental control requires a complete knowledge of physiology of plants and physical environment.Wind, precipitation, sunshine, temperature, humidity, and soil moisture are the primary factors involved to establish the existing climate or microclimate. The profitable production of crops and efficient use of water require a microclimate suitable for plant growth.Aspect i.e, direction that a slope faces and angle of slope on a geological feature are major factors in determining the influence of wind and water on a site.By the use of different types of microclimate modification techniques, like windbreak, shelterbelt, anti transparent, mulching we protect our crops, increase the production and quality as well.