



- Plant height and leaf area reduced.
- Significantly reduction in leaf weight.
- Reduced photosynthesis.
- Reduced stomatal conductance.
- Significantly reduction in the total dry matter.

➤ **Drought resistance:-**

The ability of crop plants to grow, develop and reproduce normally under moisture deficit conditions is referred to as drought resistance.

➤ **Mechanisms of Drought Resistance:**

- **Drought escape:-** Plant avoid the injury of stress by regulating its life cycle to avoid meeting with stress. This is not the kind of resistance – some short-lived, desert ephemeral plants germinate, grow and flower very quickly following seasonal rains. They thus complete their life cycle during a period of adequate moisture and form dormant seeds before the onset of dry season.
- **Drought avoidance:-**Drought avoidance refers to ability of the plant to maintain a favourable internal water balance under moisture stress. In other words, plants which avoid drought retain high water contents in their tissues. Drought avoidance can permit a longer growth period in the crop through reduced water use or increased water uptake
- **Drought tolerance :-**The ability of crop plants to withstand low tissue water content is referred to as drought tolerance. Drought tolerance is more desirable because the crop can produce more yield at lower water potential.
- **Drought resistance:-**Drought resistance is the sum of drought avoidance and drought tolerance. It refers to the ability of crop plants to give higher yield under moisture stress conditions or survival of plants under water deficit conditions without injury.

➤ **Source of Drought Resistance in Plant Breeding:**

- **Cultivated varieties:-**Transfer of drought resistance is easy from cultivated variety and germplasm of cultivated species, because such material can be easily used in the breeding programmes. Moreover, there is no problem of cross incompatibility
- **Germplasm collections**

- **Wild relatives and wild species:-**When the source of drought resistance is a wild species, the transfer of resistance poses several problems such as cross incompatibility, hybrid inviability, hybrid sterility and linkage of several undesirable genes with desirable ones. Wild sources of drought resistance have been reported in wheat, sugarcane, tomato, and several other crops.

### ➤ **Plant Breeding Methods for Drought Resistance:-**

Breeding methods for drought resistance are the same as for yield and other economic characters. Breeding for drought resistance refers to breeding for yield under soil moisture stress condition. Four breeding methods, viz.; Introduction, Selection, Hybridization, Mutations are commonly used for development of drought resistant crop cultivars.

### **Salt tolerance:**

Ability of plants to prevent, reduce or overcome injurious effects of soluble salts present in their root zone.

- Salinity can be overcome by
- **Soil reclamation:** costly, time consuming and short lived.
- **Resistant varieties:** less costly, more effective, long lasting.

### ➤ **Classification of plants based on salt tolerance:-**

- **Highly tolerant crops:** Sugar beet, barley, cotton, date palm, asparagus.
- **Moderately tolerant:** Barley, rye, sorghum, wheat, safflower, Soya bean.
- **Moderately sensitive:** Rice, corn, foxtail millet, cow pea, peanut, sugar cane, tomato, potato, radish, cabbage.
- **Extremely sensitive:** Citrus, strawberry, melon, peas, carrot, okra, onion.

### ➤ **Mechanism of salt tolerance:-**

- **Salt tolerance:** By accumulating salt, generally in their cells or glands & roots. Halophytes show tolerance by ion accumulation mechanism.
- **Salt avoidance:** By maintaining their cell salt concentration unchanged either by water absorption (e.g. Rice, chenopodiaceae) or by salt exclusion (e.g. tomato, Soya bean, citrus, wheat grass) Glycophytes (nonhalophytes) owe their resistance primarily to avoidance e.g. barley.

- **Breeding strategies:-** Breeding for yield potential should have greater emphasis than breeding for salt resistance. Selection should be done in stresses target environments Screening techniques 1. Sand culture by using nutrient solution in sand & irrigation with saline water. 2. Solution culture by using solution culture tanks 3. Micro plot techniques by using small micro plots.
- **Achievements:-** Rice : Mohan, pokkali, SR23b, SR26b, CSR-2, CSR-3, CSR-6. Onion: Hissar-2, pb selection, Karchia, Karna-92. Okra: Pusa Sawani Barley: Ratna, RS-16, Karan-18, 19, 92 Sugar cane: Co7717, Co1148, Bo9.

### **Chilling tolerance:-**

- **Chilling:** When temp remain above freezing i.e.  $>0^{\circ}\text{C}$  to  $< 10-15^{\circ}\text{C}$ .
- **Freezing:** When temp remains below freezing i.e.  $<0^{\circ}\text{C}$ .
- a) Chilling resistance:-Chilling sensitive plants are typically tropical plants. Temperate plants generally tolerate chilling injury.
- **Chilling tolerance mechanisms involve:-**Membrane lipid un-saturation, Reduced sensitivity of photosynthesis, Increased chlorophyll accumulation, Improved germination, Improved fruit/seed set,
- Pollen fertility Sources of chilling tolerance: Late adopted breeding populations e.g. maize, Germ plasm, Induced mutants for cold tolerance ,Cold tolerant somaclonal variants, Related wild species eg.tomato.

### **Mechanism of freezing resistance:-**

- **Freezing avoidance :** The ability of plant tissues / or genes to avoid ice formation at sub zero temperature Super cooling is a mechanism of freezing avoidance which is controlled by Lack of ice nucleators, Small cell size, Little or no intercellular space, Low moisture contents, Barriers against external nucleators
- **Freezing tolerance:** Ability of plants to survive the stress generated by extra cellular ice formation and to recover and re grow after thawing Components of freezing tolerance, Osmotic adjustment , Amount of bound water, Plasma membrane stability, Cell wall components properties, Cold responsive proteins, e.g. ABA

- **Genetic resources for freezing tolerance:**-Cultivated varieties, Germplasm lines, Induced mutations , Related wild species e.g. Wheat: *Agropyron* sp., Rye Oats: *Avena sterilis*  
Transgenes: e.g. chemical synthesized anti freeze protein gene, *ala3* in tobacco
- **Selection criteria:** Freezing test in laboratory, Cryo freezing, Osmoregulation, Field survival.

## BREEDING FOR BIOTIC STRESS

**Biotic stress:** Adverse conditions for crop growth and production caused by biological factors such as diseases, insects and parasitic weeds.

### Types of biotic stress:-

- i) **Vertical resistance:**-Resistance of a host to the particular race of pathogen; also called as major gene resistance, oligogenic resistance, qualitative resistance.
- ii) **Horizontal resistance:** - Resistance of a host to all the prevalent races of a pathogen; also called as minor gene resistance, polygenic resistance, nonspecific resistance, general resistance.

### Mechanism of Disease resistance:-

- **Disease escape:**-The ability of susceptible host plants to avoid attack of disease due to environmental conditions factors, early varieties, change in the date of planting, change in the site of planting; balanced application of NPK etc is called disease escape.
- **Disease endurance or tolerance:**-The ability of the plants to tolerate the invasion of the pathogen without showing much damage. This endurance is brought about by the influence of external characters. Generally, tolerance is difficult to measure since it is confounded with partial resistance and disease escape.
- **Immune reaction:**-When the host does not show the symptoms of disease it is known as immune reaction. Immunity may result from prevention of the pathogen to reach the appropriate parts of the host e.g. exclusion of spores of ovary infecting fungi by closed flowering habit of wheat and barley.
- **Hypersensitivity:**-Immediately after the infection several host cells surrounding the point of infection are so sensitive that they will die. This leads to the death of the pathogen because the rust mycelium cannot grow through the dead cells. This super sensitivity (hypersensitivity) behaves as a resistant response for all practical purposes. Phytoalexins are specific polyphenolic or terpenoid chemicals and are produced by the host in response to the infection by a pathogen.

## Sources of Disease Resistance:

- **A known variety:**-Disease reactions of most of the cultivated varieties are documented and a breeder may find the resistance he needs in a cultivated variety.
- **Germplasm collection:**-When resistance to a new disease or a new pathotype of a • disease is not known in a cultivated variety germplasm collection should be screened.
- **Related species:**-Often the resistance to a disease may be found in related species and transferred through interspecific hybridization. Eg. Resistance to stem, leaf & stripe rusts of wheat.
- **Mutation:**-Resistance to diseases may be obtained through mutation arising spontaneously or induced through mutagenic treatments. Eg, Resistance to Victoria blight in oats was induced by irradiation with x-rays or thermal neutrons / also produced spontaneously, Resistance to stripe rust in wheat, Resistance to brown rust in oats, Resistance to mildew in barley.

## Methods of Breeding for Disease Resistance:-

- **Plant Introduction:**-Process plants introduced from their native place to another place for crop improvement. Eg; Early varieties of groundnut introduced from USA have been resistant to leaf spot (Tikka). **Kalyanasona and Sonalika** wheat varieties originated from segregating material introduced from CIMMYT, Mexico, were rust resistant. African bajra introductions have been used in developing downy mildew resistant cms lines.
- **Selection:**-Kufri Red potato is selection from Darjeeling Red round , Pusa Sawani behind (yellow mosaic) selection from a collection obtained from Bihar, MCU I was selection from CO4 for black arm resistance in cotton.
- **Pedigree method:**- In wheat Kalyana Sona, Sonalaka, Malvika 12, Malvika 37, Malavika 206, Malavika 234, Laxmi in Cotton (Gadag 1 x CO2) for leaf blight resistance are agronomically highly desirable variety. If the resistant parent is a wholly unadapted variety, backcross method is a logical choice
- **Budding and Grafting:**-The disease resistance in vegetatively propagated material is transferred by adopting either by budding or grafting. By grafting or budding the resistant material, the resistance can be transferred.

- **Mutation Breeding:-**When adequate resistance is not available in the germplasm. Mutation breeding is resorted to induce resistance. This is also used to break the linkages between desirable resistant genes and other desirable genes.

### **Varieties resistant to different diseases crop variety:-**

**Rice:-** Blast Co25, Co26, **Wheat:-** all three rusts NP 809, Yellow rust NP 785, NM86, **Sugarcane :** Red rot Co 419, Co 421, Co 527, **Cotton :-** Wilt Vijay, Kalyan, Suyog, **Tikka leafspot:-**Ah 45.

### **Mechanism of Insect- Pest resistance:**

- **Non-preference:-** Various features of host plant which make the host undesirable or unattractive to insects for food, shelter or reproduction, a mechanism of insect resistance; also called non-acceptance or antixenosis.
- **Antibiosis:-** Adverse effects of the host on feeding, development and reproduction of insect pest.
- **Tolerance:-** Ability of a host to reproduce well despite the establishment of a pathogen in the host tissues or the ability of a variety to produce more yield than susceptible variety at the same level of insect attack.
- **Avoidance:-** Escape of a variety from insect attack either due to earliness or its cultivation in the season when insect population is very low.