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# **Drought Resistance**



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**Drought:** Scarcity of moisture (soil moisture) which restricts the expression of full genetic yield potential of a plant.

**Drought resistance:** The ability of crop plants to grow, develop and reproduce normally under moisture stress.

### **Mechanisms of drought resistance**

There are 4 mechanisms of drought resistance.

1. **Drought Escapes** : It is due to ability of a genotype to mature early, before occurrence of drought. Drought escape is most common in plants grown in desert region.

Eg. Early maturing varieties of sorghum, maize, bajra, wheat, rice etc; give more yield than late maturing under drought.



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**2. Drought Avoidance (Dehydration avoidance) :** It is due to the ability of plants to maintain favorable water balance even under stress. The plants which avoid drought retain high moisture content in their tissues and lose less water.

## **Drought Avoidance**

This is possible either because of :

- i) Increased water uptake (due to increase in root development) plants are called water spenders.(or) ii) Reduced water loss (due to reduction in growth of aerial parts are called water savers (i.e. to avoid transpiration)

Dehydration avoidance is interpreted as the ability of genotypes to maintain high leaf water potential when grown under soil moisture stress:



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Several traits contribute to dehydration avoidance Such as :  
Leaf rolling, folding and reflectance narrow leaves, increased pubescence on aerial organs , presence of awns, osmotic adjustment of stomata, cuticular wax, increased water uptake ; Reduced Transpiration, Increase in concentration of Abscisic Acid (ABA), closure of stomata, ABA plays role in reduction of leaf expansion, Promotion of root growth etc.

3. **Drought Tolerance** (Dehydration tolerance) : Ability of plants to produce higher yield even under ‘low water potential’. In cereals drought tolerance generally occur during reproductive phase. Tolerant cultivars exhibit better germination, seedling growth and photosynthesis. Drought tolerance may be due to

- i. high proline accumulation
- ii. maintenance of membrane integrity



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**4. Drought Resistance** : It is the sum total of avoidance and Tolerance. It refers to the genetic ability of plants to give good yield under moisture stress conditions.

## **Various morphological, physiological and biochemical features / parameters associated with drought resistance**

### **a. Morphological**

1. Earliness 2. Reduced tillering

3. Leaf characters : Leaf rolling , Leaf folding, Leaf shedding, Leaf reflectance 4. Reduced leaf area : Narrow leaf, Change in leaf angle 5. Hairiness (presence of hairs on leaf and other parts, lowers leaf temperature and reduce transpiration) 6. Colour of leaves 7. Wax content 8. Awns (eg. wheat and barley) 9. Root system (rooting depth and intensity)



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## **b. Physiological**

1. Photosynthesis (efficient system like C4) under stress, photosynthetic efficiency is reduced due to chloroplast damage.
2. Reduced Transpiration and reduced respiration losses
3. Stomatal behavior (closure of stomata, also change in size and number of stomata)
4. Osmotic adjustment
5. Leaf enlargement (increase in thickness)
6. Leaf cuticle wax (increases)



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## **C. Biochemical**

1. Accumulation of proline and betaine
2. Increase in Abscisic acid (barley) and Ethylene (maize & wheat)
3. Protein synthesis (increases under stress)
4. Nitrate – reductase activity

### **Sources of drought resistance**

1. Cultivated varieties
2. Land (old or desi primitive varieties)
3. Wild relatives (reported in several crops)



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For example :

In Wheat *Aegilops Variabilis*, *Aegilops speltoides*, *Aegilops umbellulata*, *Aegilops squarrosa* are drought resistant

In Sugarcane *Sacharum spontaneam* is resistant to Drought & salinity

#### **4. Transgenes :**

Eg. 'Rab' (Responsive to abscisic acid) in rice

#### **Screening / Evaluation**

1. Field Env. Highly desirable
2. Green house Env. More precisely controlled than field



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## **Breeding Methods and Approaches**

It is important that drought resistance can be incorporated in material with high genetic potential for yield.

1. Yield and yield components are best evaluated under non stress / optimal environments, while
2. Drought resistance must be evaluated under water stress.

### **Breeding methods :**

Methods are same as for yield and other economic characters.

Breeding for drought resistance refers to breeding for yield under moisture stress, i.e. developing varieties which can give high yields under stress. The common methods are



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1. Introduction
2. Selection
3. Hybridization
4. Mutation
5. Biotechnology

### **Limitations :**

1. Generally resistant varieties have low yield
2. Do not have much wider adaptability (as abiotic resistant is location specific)
3. Drought resistant genes may have linkage with undesirable genes.
4. Transfer of resistant genes from wild types may post problem.
5. Drought resistance is a consequence of a combination of characters and single character can be used for selection.



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6. Measurement of many drought resistant traits is difficult and problematic, since virtually all the useful drought resistant traits are under polygenic control. (So pedigree method most common). But if resistant genes is from agronomically inferior race then 1-2 backcrossing with cultivated type in made. If resistance gene is from wild species-go for backcrossing breeding. Generally selection is performed on individual plant progenies instead of individual plants (i.e. similar to line breeding)
7. Creation of controlled moisture stress Environments
8. Selection require considerable resources