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# Breeding Methods for Water Stress Tolerance in Plants

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**ABSTRACT**

*Water is the central molecule of all physiological processes of plants by being the major medium for transporting metabolites and nutrients. Factors controlling water stress condition alter the normal equilibrium and lead to a series of morphological, physiological, biochemical and molecular changes in plants which adversely affect their growth and productivity. In case of vegetables water stress drastically reduces production and productivity because of their requirement of water throughout the life cycle.*

***Key words:*** *Water stress, Crop improvement, Vegetables, Physiology, Breeding.*

## INTRODUCTION

Water is the most important factor in plant growth and development. Non availability of water drastically reduces the plant growth and thereby production and productivity. The plants responds in a several ways under water stress condition which can be stabilize the productivity per plant. The genetic potentiality of plants to cope up with water stress can be exploited by different breeding methods.

**Breeding methods**

***1. Conventional Breeding***

The conventional breeding methods involve introduction, selection and hybridization. The wild species are the reservoir of tolerance gene for biotic and abiotic stresses. Many of the species introduced as it is, for cultivating under water stress condition. *Solanum hirsutum*, *Solanum cheesmani* in tomato, *Capsicum chinense*, Arka Lohit in chilli and *Abelmoschus caillei*, *Abelmoschus tuberosus* in okra[4]. Artificial creation of water stress and selection of stress tolerant genotypes are the main steps in conventional breeding. The stress tolerant genes can be transferred into commercially cultivating varieties for the better performance under water stress condition through hybridization. The Indian bean variety Arka Vijay (Hebbal Avare x IIHR 93) which is tolerant to low moisture stress.

***2. Ideotype Breeding***

Ideotype is biological model which is expected to perform or behave in a predictable manner within a defined environment[2]. Ideotyping could be divided into three steps

- Definition of the target
- Identification of morpho-physiological traits
- Multicriteria assessment of suggested ideotypes

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### 3. Transgenic Breeding

Identification of particular gene of interest which can contribute water stress tolerance, transferring of interested gene through transgenic breeding increases the scope of crop improvement under drought condition. Over expression of transgene induces water stress tolerance. Transformation of GA methyl transferase (*ATGAMT1*) gene in tomato increased drought tolerance[5]. Manipulation of genes involved in osmoprotectant biosynthesis pathways is one of the strategies to improve stress tolerance in plants. TPS1-expressing transgenic potato lines effectively retain water under drought condition[6].

**Genes conferring drought tolerance and their salient features [1]**

| Genes | Function | Mechanism of action |
|---|---|---|
| DREBs/CBFs ABF3 | Stress induced transcription factors | Enhanced expression of downstream stress related genes confers drought/cold/salt tolerance. Constitutively overexpression can lead to stunting growth |
| SNAC1 | Stress induced transcription factor | SNAC1 expression reduces water loss increasing stomatal sensitivity to ABA |
| OsCDPK7 | Stress induced Ca-dependent protein kinase | Enhanced expression of stress responsive genes |
| Farnesyl-transferase (ERA1) | Negative-regulator of ABA sensing | Down-regulation of farnesyl transferase enhances the plant's response to ABA and drought tolerance reducing stomatal conductance |
| Mn-SOD | Mn-superoxide dismutase | Overexpression improves stress tolerance also in field conditions |
| AVP1 | Vacuolar H+ - pyrophosphatase | Overexpression facilitate auxin fluxes leading to increased root growth |

### 4. Molecular Breeding

Molecular breeding is an emerging breeding method, which could make tremendous improvements in crops. Most of the traits including stress tolerant are quantitative and strongly influenced by the environment. Quantitative Trait Loci (QTL) are the genome regions that controls the stress tolerance in plants, identification and mapping of the QTL helps in the early selection or screening of genotypes with stress tolerance. Markers also can be utilized for the identification of QTL, mapping and screening. Marker Assisted Selection (MAS), Marker Assisted Backcrossing, Marker Assisted Stacking etc. are the different approaches in molecular breeding for production of water stress tolerant genotypes. The wild *L. serriola* is a potential source of agriculturally important alleles to optimize resource acquisition by cultivated lettuce, thereby minimizing water and fertilizer inputs and ultimately enhancing water quality[3].

## CONCLUSION

The complex nature of drought tolerance limits its management through conventional breeding methods. An understanding of genetic basis of drought tolerance in vegetables is pre-requisite for plant breeders to evolve superior genotype by adopting biotechnological approaches. There is an urgent need to improve the efficiency of breeding, in order to increase productivity and reduce the gap between yield potential and yield in farmer's fields.

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