

# Overexpression of *HVA1* gene from barley generates tolerance to salinity and water stress in transgenic mulberry (*Morus indica*)

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**Abstract** Late embryogenesis abundant (LEA) proteins are members of a large group of hydrophilic proteins found primarily in plants. The barley *hva1* gene encodes a group 3 LEA protein and is induced by ABA and water deficit conditions. We report here the over expression of *hva1* in mulberry under a constitutive promoter via *Agrobacterium*-mediated transformation. Molecular analysis of the transgenic plants revealed the stable integration and expression of the transgene in the transformants. Transgenic plants were subjected to simulated salinity and drought stress conditions to study the role of *hva1* in conferring tolerance. The transgenic plants showed better cellular membrane stability (CMS), photosynthetic yield, less photo-oxidative damage and better water use efficiency as compared to the non-transgenic plants under both salinity and drought stress. Under salinity stress, transgenic plants show many fold increase in proline concentration than the non-transgenic plants and under water deficit conditions proline is accumulated only in the non-transgenic plants. Results also indicate that the production of HVA1 proteins helps in better performance of transgenic mulberry by protecting membrane stability of plasma membrane as well as chloroplastic

membranes from injury under abiotic stress. Interestingly, it was observed that *hva1* conferred different degrees of tolerance to the transgenic plants towards various stress conditions. Amongst the lines analysed for stress tolerance transgenic line ST8 was relatively more salt tolerant, ST30, ST31 more drought tolerant, and lines ST11 and ST6 responded well under both salinity and drought stress conditions as compared to the non-transgenic plants. Thus *hva1* appears to confer a broad spectrum of tolerance under abiotic stress in mulberry.

**Keywords** CMS · Drought · *hva1* · LEA · Proline · Mulberry · Salinity · Transgenic · WUE

## Abbreviations

|      |                                     |
|------|-------------------------------------|
| ABA  | Abscisic acid                       |
| CMS  | Cellular membrane stability         |
| DW   | Dry weight                          |
| FW   | Fresh weight                        |
| IRMS | Isotope ratio mass spectrometry     |
| LEA  | Late embryogenesis abundant protein |
| MS   | Murashige and Skoog                 |
| RBD  | Randomized block design             |
| RWC  | Relative water content              |
| TDZ  | Thidiazuron                         |
| TW   | Turgid weight                       |
| WUE  | Water use efficiency                |
| YEM  | Yeast extract mannitol              |

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