Unlocking Chickpea Potential: AtBAG4, the Cytoprotective Co-Chaperone, Enhances Drought Tolerance, Nodulation and Seed Protein Content

Thanthrige, N1,., Weston-Olliver, G1., Das Bhowmik, S1., Friedl, J1., Rowlings, D1., Kabbage, M3., Ferguson, B.J2., Mundree, S1., and Williams, B1\*

[*b.williams@qut.edu.au*](mailto:b.williams@qut.edu.au)

1School of Biology and Environmental Science, Queensland University of Technology, Queensland, Australia

2School of Agriculture and Food Sciences, University of Queensland, Queensland, Australia

3Department of Plant Pathology, University of Wisconsin-Madison, Wisconsin, United States of America

Drought and extreme temperatures significantly limit chickpea productivity worldwide. The regulation of plant programmed cell death pathways is emerging as a key component of plant stress responses, maintaining cellular homeostasis, and enhancing crop resilience to environmental challenges. Arabidopsis thaliana Bcl-2 associated athanogene 4 (AtBAG4) is a cytoprotective co-chaperone implicated in plant stress responses. In this study, we explore the effects of exogenous expression of AtBAG4 on chickpea stress tolerance, nodulation and nitrogen fixation. Transgenic chickpea lines engineered to constitutively express AtBAG4 are more drought tolerant and produce higher yields under drought stress compared to non-transgenic controls in the field. Additionally, the AtBAG4 expressing transgenic lines supported higher nodulation, increased photosynthetic activity and elevated nitrogen fixation. The increased photosynthetic activity and nitrogen fixation resulted in seeds with higher nitrogen content. These findings suggest that using protective chaperone genes like AtBAG4 has the potential to significantly improve crop performance, especially under unpredictable climate conditions. Importantly, these improvements were achieved with minimal impact on yields under both well-watered and drought conditions. This research highlights a promising approach for sustainable agriculture in the future.