Climate-Smart Brassica Cultivar Development through Molecular Marker-Based Selection for Enhanced Food Security

Muhammad Mahran Aslam
Nuclear Institute of Agriculture (NIA), Tandojam-70060-Sindh, Pakistan
*E-mail: mahranpbg@gmail.com

ABSTRACT

Pakistan, like many other countries, faces the challenges of climate change, which has direct implications for its agriculture. This article explores the imperative need for climate-smart cultivar development within the Brassica genus to address the challenges posed by climate change and enhance global food security. The study employs molecular marker-based selection methods to identify and characterize genetic traits that contribute to climate resilience in Brassica cultivars. The research focuses on leveraging advanced genomic tools to pinpoint markers associated with traits such as drought tolerance, heat resistance, and pest resilience, thereby facilitating the targeted breeding of climate-smart cultivars. By integrating state-of-the-art molecular techniques, this work aims to accelerate the breeding process, ensuring the rapid deployment of robust Brassica cultivars capable of thriving in diverse climatic conditions.

Keywords: Climate-smart cultivars, Brassica germplasm, Molecular marker-based selection and Climate resilience

INTRODUCTION

As global climate change accelerates, agriculture faces unprecedented challenges. Among the most vulnerable crops are Brassica species, including essential oilseed and vegetable varieties (Jägermeyr et al., 2021). To address these challenges and bolster food security, our project focuses on developing climate-smart Brassica cultivars using state-of-the-art molecular marker-based selection techniques (Barrett, 2021; Wegren, 2023).

Brassica crops are vital contributors to the world's food supply, offering nutritious oils, vegetables, and livestock feed. However, rising temperatures, shifting precipitation patterns, and the increasing prevalence of extreme weather events threaten their productivity. (He et al., 2021)Traditional breeding methods are time-consuming and often insufficient to rapidly adapt crops to changing climates. In this context, molecular markers offer a promising solution (Steinwand and Ronald, 2020). Ultimately, this project represents a vital step towards a more climate-resilient and sustainable future for Brassica agriculture, providing a blueprint for adapting other crops to the challenges of our changing climate. Through the innovative use of molecular markers, we strive to secure the availability of nutritious Brassica products and strengthen global food security.

OBJECTIVE

The overarching objective of this study is to contribute to global food security by developing climate-smart Brassica cultivars that exhibit resilience to the adverse effects of climate change. The research emphasizes the utilization of molecular marker-based selection to expedite the breeding process and enhance the efficiency of developing cultivars with heightened adaptability and productivity.

METHODOLOGY

The methodology encompasses the systematic identification and analysis of molecular markers associated with key climate-resilient traits in Brassica species. Through extensive genomic profiling, the study aims to correlate specific genetic markers with traits such as drought tolerance, heat resistance, and resistance to common pests. Subsequently, these markers will be employed for precise and targeted breeding, ensuring the selection of cultivars with optimal traits. The research integrates cutting-edge molecular biology techniques, including marker-assisted selection and high-throughput genotyping, to expedite the identification and validation of desirable traits in Brassica cultivars.

RESULTS

The acquisition of a diverse range of germplasm and materials exhibiting robust resistance to stressors such as drought, heat, and insect pests has been a key accomplishment. Through meticulous screening, we have identified promising lines with superior resilience and adaptability. Multilocation trials in the Sindh province have validated their potential, showcasing noteworthy performance under varying environmental conditions. This progress is a crucial step towards developing climate-resilient brassica varieties. From the trials, we have identified 5-6 potential candidate mutants, providing valuable data and insights. This sets the stage for cultivating robust and sustainable cultivars capable of withstanding climate change challenges, ultimately contributing to improved food security and agricultural resilience.

CONCLUSION

our research signifies a significant leap towards developing climate-smart brassica cultivars through molecular marker-based selection. The identification of resilient lines and potential mutants, coupled with their successful performance in multilocation trials, underscores the promise of creating robust and sustainable varieties.

ACKNOWLEDGMENT

The authors extend heartfelt thanks to the Nuclear Institute of Agriculture (NIA), Tandojam-70060, Sindh, Pakistan, for their crucial support and resources, enabling the successful execution of this research

REFERENCES

1. Barrett, C. B. (2021). Overcoming Global Food Security Challenges through Science and Solidarity. American Journal of Agricultural Economics 103, 422-447.
2. He, Z., Ji, R., Havlickova, L., Wang, L., Li, Y., Lee, H. T., Song, J., Koh, C., Yang, J., Zhang, M., Parkin, I. A. P., Wang, X., Edwards, D., King, G. J., Zou, J., Liu, K., Snowdon, R. J., Banga, S. S., Machackova, I., and Bancroft, I. (2021). Genome structural evolution in Brassica crops. Nature Plants 7, 757-765.
3. Jägermeyr, J., Müller, C., Ruane, A. C., Elliott, J., Balkovic, J., Castillo, O., Faye, B., Foster, I., Folberth, C., Franke, J. A., Fuchs, K., Guarin, J. R., Heinke, J., Hoogenboom, G., Iizumi, T., Jain, A. K., Kelly, D., Khabarov, N., Lange, S., Lin, T.-S., Liu, W., Mialyk, O., Minoli, S., Moyer, E. J., Okada, M., Phillips, M., Porter, C., Rabin, S. S., Scheer, C., Schneider, J. M., Schyns, J. F., Skalsky, R., Smerald, A., Stella, T., Stephens, H., Webber, H., Zabel, F., and Rosenzweig, C. (2021). Climate impacts on global agriculture emerge earlier in new generation of climate and crop models. Nature Food 2, 873-885.
4. Steinwand, M. A., and Ronald, P. C. (2020). Crop biotechnology and the future of food. Nature Food 1, 273-283.
5. Wegren, S. K. (2023). Challenges to global food security: A policy approach to the 2021–2022 food crisis. World Food Policy 9, 127-148.