**Genomic Prediction in Faba bean for Heat and Herbicide Tolerance**

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Genomic selection (GS) offers significant potential to enhance genetic gain. The present study aimed to evaluate the accuracy and potential of GS in faba bean (*Vicia faba* L.), and to identify areas for further improvement and better implementation in practical breeding programs.

125 diverse faba bean accessions were phenotyped for different agronomic traits under herbicide and heat stresses in 16 environments in Morocco, Lebanon, Sudan and the USA. These accessions were also genotyped. 170 SNPs highly associated with the target traits were identified. Subsequently, KASP markers were designed and validated across 4515 diverse breeding lines. Prediction accuracy (PA) was evaluated using the reproducing kernel Hilbert space model with and without considering genotype by environment interaction and considering two cross-validation strategies (CV1: predicting new lines; CV2: predicting complete records from unbalanced data). In addition, 75 KASP markers targeting heat tolerance traits were prioritized and used to estimate the PA of the models.

The findings indicated comparable PA between the two models. CV1 outperformed CV2, highlighting the challenge of predicting the performance of untested lines in tested environments compared to lines that were evaluated in some environments but not in others. Furthermore, the subset size and composition of SNPs significantly influenced PA, particularly under heat stress conditions. Notably, the highest accuracies were achieved for days to flowering and plant height, suggesting that these traits are suitable for use in training population selection. Optimizing the size and composition of the training population holds promise for successful application of GS in faba bean.