Unveiling New Insights into Faba Bean Sensitivity and Genetic Responses to the Mutagen Agent EMS (Ethyl Methanesulfonate)

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Mutagenesis breeding via Ethyl Methanesulfonate (EMS) has been successfully used in faba bean to improve some economically important traits. However, there is a knowledge gap of the factors/mechanisms related to its sensitivity/tolerance to EMS treatment toxicity. It was hypothesized that seed size could influence the response of the diverse botanical varieties of faba bean. Consequently, we conducted a comprehensive assessment of the sensitivity of six faba bean varieties: three major varieties (Aguadulce Superlonga, Reina Mora, Yasmine) and three minor varieties (Zina, Alfia05, and Alfia17), to three increasing concentrations (0.05%, 0.5%, and 1%, along with a control 0%) of EMS. Analyses included various germination parameters (germination percentage (GP), germination energy at 7 and 14 days (GE7, GE14), germination rate index (GRI) and vigor index (VI)) across different EMS concentrations. To further explore mechanisms involved in sensitivity to EMS, we measured coat thickness and assessed antioxidant activity. Our findings revealed the variation in seed size did not affect significantly the sensitivity to EMS, while different varieties displayed significant differences in their responses to increasing EMS concentrations (p<0.05) across all parameters, except for root length. These findings challenge the prevailing assumption that seed size influences EMS sensitivity in faba bean, as hypothesized and suggested in existing literature. Coat thickness exhibited consistent uniformity, indicating similar EMS absorption patterns. Finally, antioxidant activity assessed through the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) assay revealed significant variations between non-treated and EMS treated groups, highlighting adaptations in antioxidant defense mechanisms. Correlations between antioxidant activity and germination parameters under EMS treatment were significant, which emphasize the role of antioxidants in tolerance to EMS. The study suggests that factors beyond seed size contribute to responses to EMS, and detailed examination of antioxidant systems can elucidate the plant's ability to counteract EMS-induced oxidative stress.