Does early growth estimation using remote sensing help our understanding of genotypic stability for lentil varietal selection under heat stress?

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Genotype by environment interaction (GEI) affects genetic gain in developing varieties under abiotic stress. Understanding this interaction at early crop growth stage is essential to identify the most stable breeding lines across a wide range of production environments. With this objective, we evaluated 156 lentil genotypes across contrasting sowing dates and environments for heat stress tolerance in 2023. Using Unmanned Aerial Vehicle, we collected phenotypic data, such as ground cover, crop growth and development and plant stress levels. Early vigour was calculated using digital ground cover, NDVI and OSAVI indices. Significant variation for the indices were observed among the genotypes evaluated. GEI for early vigour trait was also significant. This identified several genotypes with higher early vigour and broader environmental adaptation and vice versa. Based on the Additive main effects and multiplicative interaction model, the genotypes were grouped into four clusters. Genotypes in cluster 4 were classified as the most unstable and poor in early vigour. These genotypes were highly sensitive to GEI. Using early vigour data, we also evaluated the performance of top 20 and 30% of the population and compared these to three commercial varieties and population mean. In general, higher genetic gain was observed compared to the released varieties and mean population, which suggests a genetic advantage associated with germplasm evaluated in these trials. In some of the environments, early vigour was significantly associated to seed yield. Overall, vegetation indices derived from aerial based sensor were capable of ranking genotypes for stability and early vigour performance across different environments and sowing times.

**Keywords**: Broad adaptation, Early growth, GEI, Genetic Gain, Specific adaptation, Stability

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