Exploring Maize Stress Response Phenotypes via High-Throughput Imaging

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Abstract

This study aimed to investigate the physiological and morphological responses of maize seedlings to environmental stressors. High-throughput imaging analysis was used to characterize the stress response phenotypes of 47 distinct maize genotypes exposed to water limitation (40% field capacity), heat (38 °C), and the combination of the two stresses. RGB and NIR images were collected daily, and analyzed with open-source, open-development software PlantCV. Our investigation focused on quantitative measurements of daily area, daily water loss, evaluation of estimated water use efficiency (WUE), and near-infrared (NIR) reflectance as an estimation of water content in tissues. Quantitatively comparing two non-normal distributions, like the NIR histogram data, can be challenging but important, since metrics like median mode values often do not capture variation across a sample. One of the primary obstacles lies in defining an appropriate metric to accurately quantify the variation between two distributions. To analyze NIR reflectance, we evaluated the dissimilarity between pairwise NIR histograms by utilizing the earth mover's distance (EMD) analysis. The EMD quantifies the difference between two NIR reflectance distributions, and therefore indirectly evaluates the difference in leaf water content for stress vs control conditions. Overall, most genotypes displayed growth reduction under drought and heat. Interestingly, specific lines exhibited heightened WUE under water limitation, suggesting response to water scarcity. EMD results showing dissimilarities in pairwise NIR reflectance of control vs drought, can be used to describe variation in dynamic changes in water content levels among these groups.

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