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Textural characteristics of wheat grain images from the ITMI population

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Motivation and aim: Wheat grain texture in images characterizes the structural properties of its coat. These properties may influence grain susceptibility to pests and mechanical damage. Texture features are less studied in digital images of grains compared to color and morphological characteristics. In this study, 16 texture features of wheat grains from the ITMI population were estimated in images using the Gray Level Co-occurrence Matrix (GLCM) and the Gray Level Run-Length Matrix (GLRM) [1]. The aim is to describe the diversity of grain coat properties in wheat, understand their relationship with genetic and environmental factors, evaluate their changes during storage, and assess their potential as markers for breeding programs.
Methods and Algorithms: Texture characteristics included homogeneity, entropy, cluster shade, run ratios, and other properties estimated from the Gray Level Co-occurrence Matrix (GLCM) and the Gray Level Run-Length Matrix (GLRM). Hierarchical cluster analysis (HCA) [2] was used to compare texture traits with color and morphological features. Principal component analysis (PCA) [3] identified the most variable texture traits in the ITMI population. ANOVA [2] was performed to assess the relationships between texture and genetic (genotype) and environmental (harvest year) factors. Linear correlation analysis, supported by permutation and bootstrap testing, explored the linear relationships between texture traits and storage duration.
Results: In the HCA diagram texture traits form separate clusters suggesting their independence of other grain features. PCA revealed two main components of variation: surface roughness (PC1) and wrinkling (PC2), effectively separating genotypes based on texture. ANOVA showed that both genetic and environmental factors influence texture traits, genotype affects more traits. Correlation analysis demonstrated that uniformity-related traits tended to increase over time, while complexity-related features, such as contrast and roughness, decreased. Permutation and bootstrap methods [2] validated the observed correlations.
Conclusions: Texture features of wheat grains in the images demonstrated large variation in the ITMI population. They are independent of other traits suggesting they are under different genetic control. Future work should focus on linking these changes to biochemical processes and refining methods for their practical application in wheat breeding and storage management.
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References

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