Stomatic Traits as Diagnostic Markers of Ploidy: A Microscopy-Based Approach in Wheat

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Abstract

Stomatal morphology, specifically size and density, has emerged as a reliable and accurate morphological marker for determining ploidy levels in crops like wheat (T.aestivum). Despite being the gold standard for ploidy determination, the limitations of flow cytometry highlight the need for more economic and field-deployable alternatives. This study reviews recent research showing that as ploidy levels increase, stomatal size tends to increase while density decreases, making these traits useful as simple, visual indicators of nuclear DNA content. Diploid wheat typically exhibits small but numerous stomata per unit area compared to the hexaploids that tend to have larger but fewer stomata. These trends are consistent across both field and controlled environments, as confirmed by studies using microscopy and image-based analysis. The potential integration of machine learning tools with image processing opens a doorway to developing non-destructive, high-throughput screening systems for ploidy analysis in breeding programs. Furthermore, while diploid and polyploid species receive considerable attention, haploid wheat species remain underexplored, indicating a significant research gap. This review suggests a framework for future experimental validation, involving light microscopy, stomatal imaging with ImageJ/Fiji, and model training through AI algorithms to enable automated classification. With further calibration and multi-environment validation, this approach may evolve into a reliable phenotyping strategy in plant cytogenetics.

Keywords

Stomatal traits, ploidy, polyploidy, wheat, microscopy.