Tropentag, September 11-13, 2024, hybrid conference

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A simple algorithm outperforms a machine learning approach for quantifying spittlebug damage in tropical grasses

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Abstract

In the extensive livestock systems of tropical America, host-plant resistance has proven to be the most efficient strategy for integrated pest management in forage grasses (i.e., *Urochloa* hybrids and *Megathyrsus maximus*) to spittlebug (Hemiptera: Cercopidae) attack. Precise and efficient quantification of spittlebug damage is crucial for evaluation and selection of resistant and tolerant genotypes in the *Urochloa* spp. and *M. maximus* breeding programmes at CIAT. Traditional methods rely on visual inspection by experts, which is a time-consuming and resource-intensive process. Recent advancements in image processing offer the potential for automated high-throughput (HTP) analyses pipelines. The proposed pipeline involves image pre-processing (normalisation, feature enhancement, and plant segmentation) followed by a damage segmentation algorithm. Considering the large data volumes in breeding trials, where five replicates of 150 genotypes are assessed to spittlebug damage, often with limited availability of ground truth data, unsupervised learning approaches like clustering are preferred for damage segmentation. Furthermore, real-world image acquisition introduces challenges due to variability in lighting, noise, and lack of standardisation. The objective of this study was to compare a simple algorithm (Heckbert's median-cut colour quantisation) with the k-means unsupervised machine learning approach for quantification of plant damage (green/chlorotic leaf tissue) by spittlebugs using colour images. Our results showed that Heckbert's median-cut colour quantisation delivers similar results of quantification of plant damage to those obtained by K-means, yet, at a faster speed and less usage of CPU processing. We conclude that Heckbert's median-cut colour quantisation provides a computationally efficient and accurate solution for HTP spittlebug damage analysis of tropical forage grasses in CPU resource-constrained devices. This will facilitate the implementation of automated image analyses of spittlebug damage of tropical forage grasses for researchers working with old computers or mobile devices.

Keywords: Clustering algorithms, colour quantisation, damage segmentation, image processing, k-means, plant phenotyping, tropical forages

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