
Photo by Paula Espitia/CIAT

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

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INTRODUCTION

- High-throughput phenotyping (HTP) offers the potential for a fast-paced, automated and more robust analysis on plant images for phenotyping purposes like plant damage quantification.
- Many times, the limiting factor resides on the lack of labeled data for training. In those cases, the use of unsupervised machine learning techniques like the k-means clustering algorithm can be applied.
- However, classical image processing algorithms like Heckbert's median-cut algorithm for color quantization, already available in different software tools, can also be applied to some extent.

OBJECTIVE

Assess the performance of classical color quantization vs machine learning k-means for damage quantification on images of spittlebug infected tropical grasses.

METHODOLOGY

METHODOLOGY: NO CHOICE TEST

1 EXPERIMENTAL UNITS PREPARATION
Single-tiller cuttings
4 weeks old

2 SPITTLEBUG EGGS
Infestation per experimental unit with
6 eggs | 2 adults

3 IMAGE ACQUISITION FOR DAMAGE QUANTIFICATION

NYMPHS	ADULTS
• Before infestation	• Before infestation
• 35 dai	• 2 wai
	• 3 wai

dai: days after infestation
wai: weeks after infestation



METHODOLOGY: DIGITAL IMAGE ANALYSIS

1 IMAGE ACQUISITION IN LIGHT BOX (LED 6000k)
CAMERA SETUP:
- Manual mode
- Focus mode AF-A single point
- White balance: 0.0 in the fluorescent mode
- ISO: 100
- Shutter speed: 1/50s
  Aperture: 5.6

2 PREPROCESSING
- Normalization of the blue channel (B/R+G+B)
- Background segmentation
- Enhance contrast between green and yellow pixels (G-R)
- Color quantization to 3 categories

3 DAMAGE QUANTIFICATION

$$\text{Dam. \%} = \frac{SP}{SP+GP} \times 100$$

SP: Damaged pixels (yellow and dead)
GP: Green pixels

Figure 1. Methodology for data acquisition and digital image analysis.

RESULTS

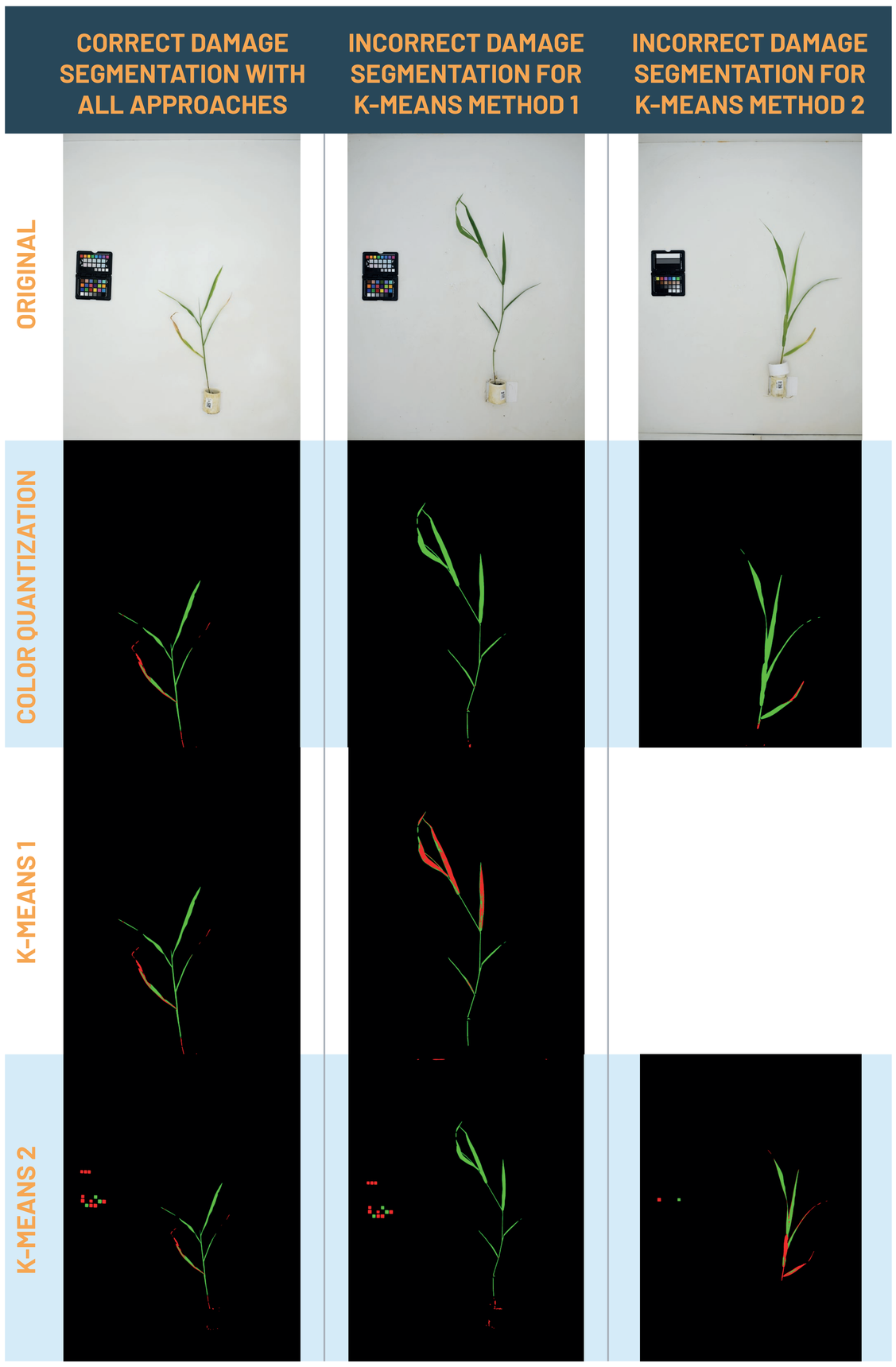

Figure 2. Sample results using the different approaches. K-means for cropped (method 1) and uncropped (method 2) generated incorrect results in several instances compared to color quantization.

CONCLUSIONS

- Color quantization was more accurate measuring the plant damage in Urochloa assisting the selection of tolerant genotypes for breeding.
- Damaged areas can serve as annotations for training a robust model using deep learning algorithms for plant damage caused by spittlebugs.

REFERENCES

Murphy, K. M., Ludwig, E., Gutierrez, J., & Gehan, M. A. (2024). Deep Learning in Image-Based Plant Phenotyping. Annual Review of Plant Biology, 75(Volume 75, 2024), 771–795. https://doi.org/10.1146/annurev-arplant-070523-042828

ACKNOWLEDGEMENTS

This work was conducted as part of the CGIAR Initiatives on Accelerated Breeding (ABI) and Sustainable Animal Productivity (SAP). We thank all donors who globally support our work through their contributions to the CGIAR System.

Alianza Bioversity & CIAT
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POSTER PREPARED FOR
Tropentag 2024
September 11–13, 2024
Vienna (Austria)