A Multi-Stage Deep Learning Framework for Classification and Severity Quantification of Maize Gray Leaf Spot With Integrated Management Recommendations (DeGLS)

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Gray Leaf Spot (GLS), caused by the fungal pathogens Cercospora zeae-maydis and Cercospora zeina, represents a significant challenge in corn production, resulting in annual economic losses amounting to billions of dollars. Conventional methods for assessing GLS severity are limited by high labor demands, subjectivity, and frequent inaccuracies. This study investigates the application of deep learning for automating GLS severity assessment, focusing on comparing the performances of a multi-model detection framework utilizing YOLOv8 Computer Vision Model and U-Net Convolutional Neural Network (CNN) to human experts in terms of accuracy and consistency. The YOLOv8 model was first utilized to extract leaf regions and disease type, followed by the U-Net CNN model to segment GLS lesions and calculate percent severity. The models were trained on the PlantVillage and Corn Disease & Severity datasets containing corn leaves infected with various diseases. GLS severity assessments produced by the models showed a strong correlation and exhibited even higher levels of consistency than expert human evaluations, potentially making it a reliable tool for automated disease assessment. A third LLM model was integrated for field-application, providing tailored management strategies based on data from the first two models and implementing integrated disease scores from multiple leaves and plants. Indexing and time-series algorithms allow for yield impact predictions. Future studies will focus on integrating machine learning methods with field and greenhouse applications, and exploring their applications in other plant diseases.

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