Time Lapse Photography for High-Throughput Phenotyping of Corn

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Stefan Hey, postdoctoral researcher
Lisa Coffey, nursery manager
Plant Sciences Institute
Zaki Jubery, postdoctoral researcher
Baskar Ganapathysubramanian,
associate professor
Department of Mechanical Engineering
Patrick Schnable, distinguished professor
Department of Agronomy

Introduction

Comprehensive assessment of plant performance requires taking various measurements in the field throughout the growing season. These measurements are time consuming. To increase the sampling frequency of trait assessment, a time-lapse photography system was developed. The cameras take images at user-specified intervals (e.g., every 15 minutes) throughout the growing season, which allows us to measure various plant traits at a high frequency with minimal daily labor.

Materials and Methods

A maize diversity panel, comprising 380 different inbred lines, was planted at two ISU research farms: the Curtiss Farm and the Ag Engineering/Agronomy Farm. One replication was planted at each location. Consumer-grade point-and-shoot cameras were mounted on poles positioned to image the row from the side, so multiple plants from a single inbred are imaged by a single camera. The cameras are controlled by Raspberry Pis (a credit card sized minicomputer). The Raspberry Pis are connected to a server located in the field, and the server downloads and stores all of the images locally (Figure 1).

At the end of the growing season, the images are analyzed via Amazon Mechanical Turks, a crowdsourcing platform for rapid annotation of all the images taken. Plants were marked in images by drawing lines (Figure 2A). These lines were used to assess increases in plant height throughout the growing season.

Results and Discussion

A total of 851,000 images were collected from 380 cameras. One image per day was sampled to extract plant height (Figure 2B). Image analysis was crowdsourced multiple times to assess Turker accuracy, which allowed us to remove inaccurate measurements. The resulting growth rate data are being used to study genotype x environment interactions.

Acknowledgements

Figure 1. Camera system in Ag Engineering/Agronomy Farm field in 2018. Throughout the growing season, 380 cameras were deployed in the field.
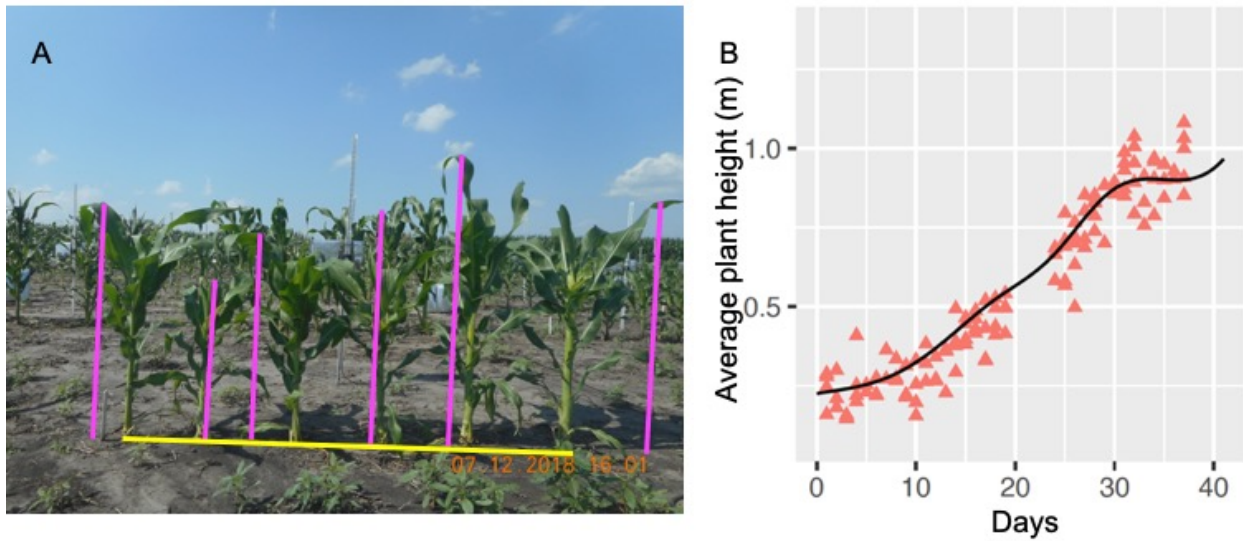

Figure 2. Plant height measurements. A) lines were drawn of all 6 plants in one row. The length of the line corresponds to the height of the plant. B) height measurements were plotted over time.