Strawberry Breeding Assisted with Plant Phenome AI Model

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Introduction

Strawberry is an intensive crop with growing production and pest management requirements to keep up with the ever-growing market needs and challenges. Thus, research advances that can assist and accelerate the breeding of new varieties have never been as important.

Traditional strawberry breeding is tasking research that requires the evaluation of plant phenome characteristics such as morphology, physiology, and the development of thousands of individual plants to be narrowed down to one or two commercially viable and competitive varieties.

Benefits of AI-based models in plant breeding research

1. Facilitate mass data collection.
2. Facilitate and accelerate analysis.
3. Improve data accuracy and precision.
4. Reduce and mitigate human biases.
5. Improve long-term reliability.
6. Provides explainable information.
7. Reduce required resources.

Figure 1: Strawberry Encore™. One of the latest two varieties commercially resealed by University of Florida Strawberry Breeding Program in 2024. Breeding Encore™ utilized the AI Plant Phenome model.

Hypothesis

An AI-based model can greatly assist strawberry breeders and speed up the release of new commercial varieties.

Objective

Use Plant Phenome AI model to accelerate the plant breeding process and reduce the required intensive resources and time demands of traditional breeding.

Methodology

Aerial or ground-based images of strawberry plants are captured in the field. Images are uploaded to the cloud for raw processing and plant phenome characterization (Fig 2). Various data parameters such as biomass, and development rate are evaluated to advise the plant variety selection process.

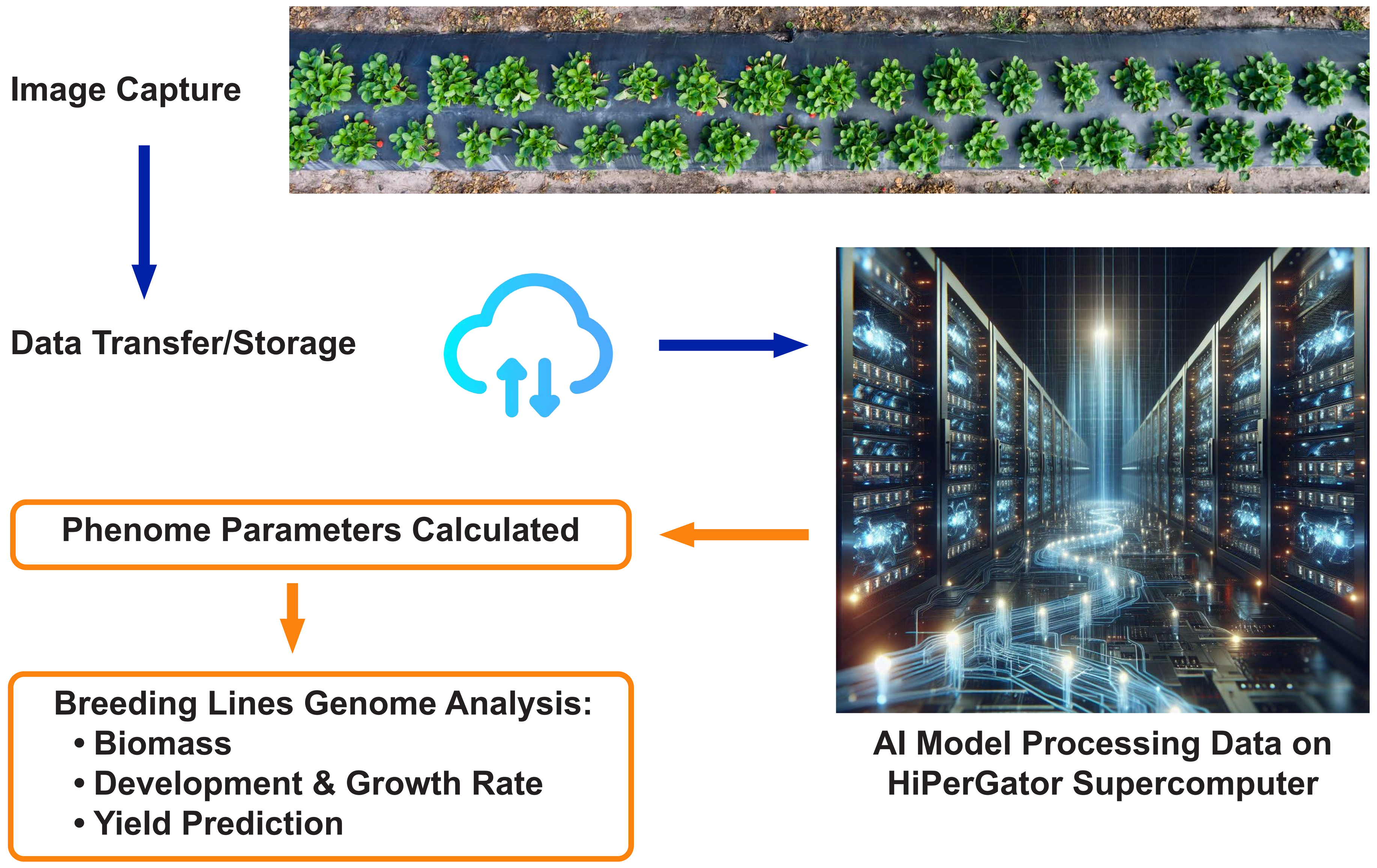

Figure 2: AI assisted breeding pathway begins with image capture, data transfer, and visual analysis. Then plant phenome parameters are quantified and examined to advise breeding decisions.

Results

Non-destructive imaging sampling over time of breeding lines provides the biomass and growth rates data (Fig 3). Plant canopy image AI visualization calculates the biomass of individual plant data and is tracked throughout the growing season (Fig 4). Growth rate and plant development are plotted over time to illustrate growth rates throughout the season (Fig 5). Canopy size and growth rates across time are then correlated with flowering and fruiting rates to measure performance among the selection breeding lines and during early, peak, and late production seasons.

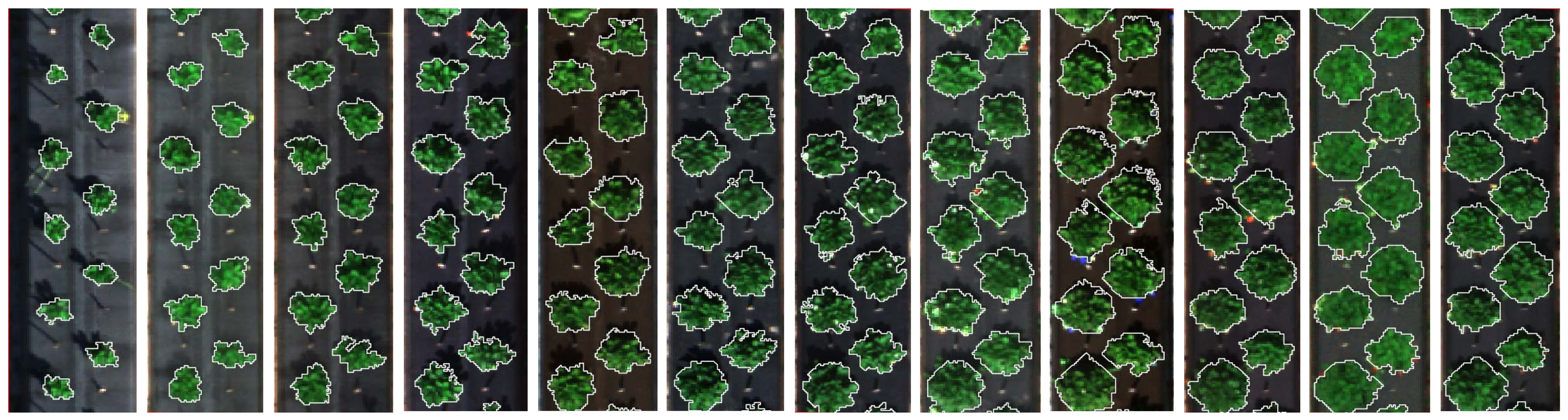

Figure 3: Strawberry breeding research plots' imaging during the 2021 season. Weekly imaging shows the growth and development of the individual plants from left to right. AI-analyzed images can detect and track certain phenome traits over time such as biomass. Elwakil, et.al 2024

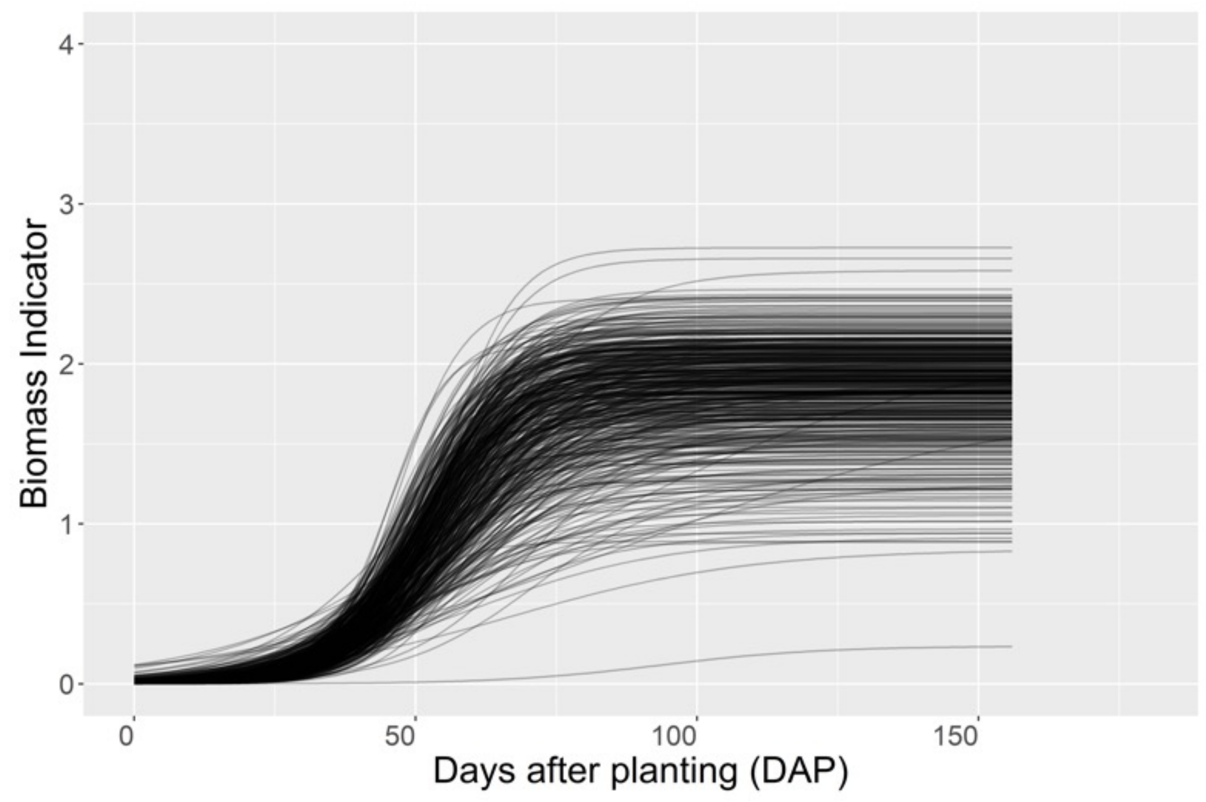

Figure 4: AI model calculated biomass data of each breading line are plotted over time (days after planting).

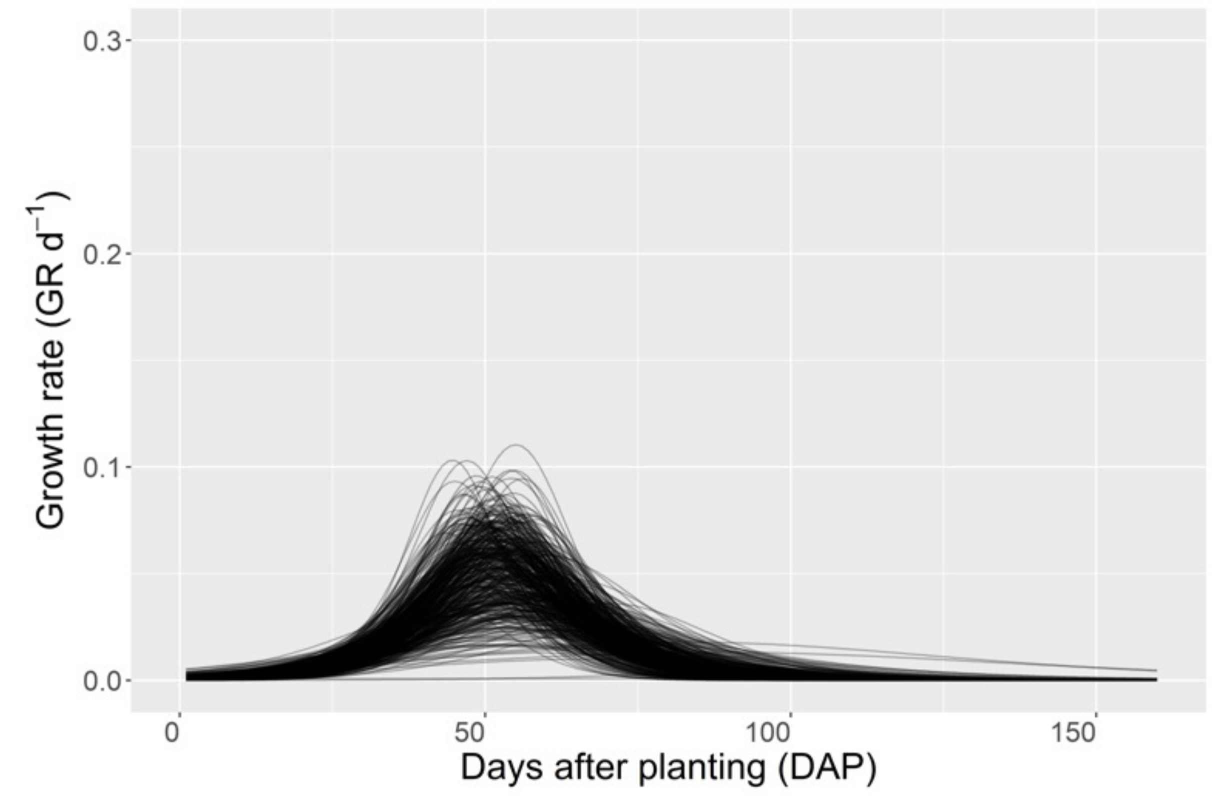

Figure 5: Growth rates over time showing development and growth shifts throughout the different parts of the production season (early, peak, and late).

Conclusions

Using this plant phenome AI model offers a non-destructive sampling method to measure strawberry plant growth and reproduction parameters.

Medium size biomass can be a favorable characteristic to commercial producers which generally translates to a desirable reproduction rate without sacrificing ease of harvest that can be lost with dense plant canopies. Consistency of plant development can ensure the predictability of harvest volumes throughout the season. However, early producing varieties can offer a great advantage during higher winter market prices.

This offers great advantages in comparison to traditional destructive sampling methods which require more man hours, test plants, field or greenhouse space, and associated higher costs.

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References

• Elwakil, W., and Wang, X. 2024. Plant Phenome AI Accelerating Variety Breeding. PLH126, UF/IFAS Extension. www.t.ly/ivmcy
• Pasala, R., and Pandey, B.B. 2020. Plant phenomics: High-Throughput Technology for Accelerating Genomics. J Biosci 45, 111. https://doi.org/10.1007/s12038-020-00083-w
• Guan, Z., Abd-Elrahman, A., Fan, Z., Whitaker, V., and Wilkinson, B. 2020. Modeling Strawberry Biomass and Leaf Area Using Object-Based Analysis of High-Resolution Images. J Photogrammetry and Remote Sensing 163, 171-186. https://doi.org/10.1016/j.isprsjprs.2020.02.021