GPC Project #: ROBOT

EVALUATION AND DEVELOPMENT OF HIGH-THROUGHPUT PHENOTYPING TECHNOLOGIES FOR PEANUT

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Plant breeding is a numbers game. The more unique progeny a breeding program can evaluate, the higher their chances of identifying breeding lines with significantly improved performance. Equally important to breeding data quantity is data quality. Therefore, it is incumbent on breeders to continually investigate and develop improved methods of phenotyping that are faster, more precise, cheaper, or all of these things.

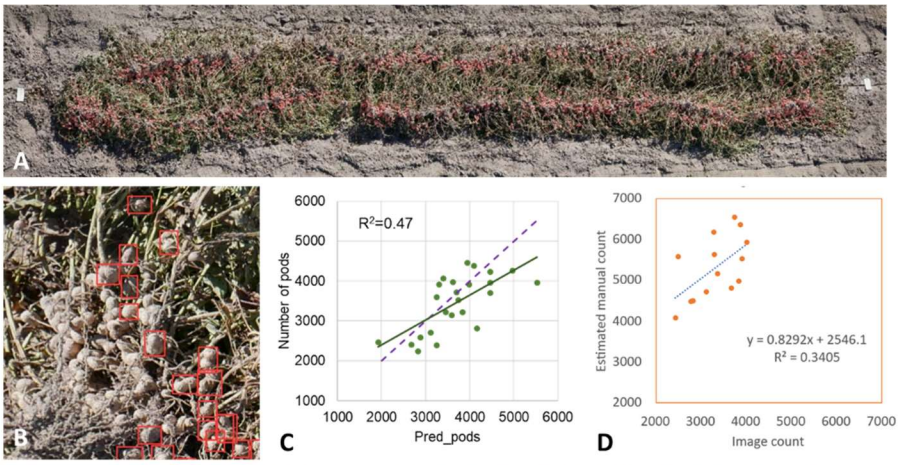

Figure 1*. Images taken by robot-mounted cameras were stitched to form a composite image from approximately 40 individual images taken by two cameras prior to harvest in 2023. (B) Peanut pods were manually tagged (red boxes) to feed into the AI program to train the model. Different models were tested in 2022 (C) and 2023 (D) to autonomously recognize peanut pods in the images. Further analysis of 2023 data is ongoing.*

In 2019, some members of our group began a collaboration to develop high-throughput phenotyping (HTP) methods for peanut breeding research using unmanned aerial systems (UAS), or "drones". Following the positive results from those experiments, in 2021, our group began the planning and design of an automated, ground-based, high-throughput phenotyping robot specifically designed for the conditions found in peanut fields. In 2022, we were able to test the prototype in the field and collect some initial data. There were several set-backs that we encountered during testing last year, including issues with the automated guidance. However, those challenges have been addressed, and we were able to collect a large amount of data with the robot in time for harvest in 2023.

We are currently using artificial intelligence systems (AI) to build an algorithm to identify peanut pods in images taken by Watson in 2023 (**Figure 1**). Once the image analysis is complete, we will compare actual yield and estimated pod counts to the data generated from the robot images. Our goal is to eventually have the computer do this analysis "on the go" in the field without the need for human intervention or for secondary image analysis. There are many other traits that we are interested to measure with the robot in the coming years. Our intent has been to first deploy the robot in breeding trials, but other research programs will eventually also benefit from this technology. It could even be used some day to scout grower's fields for disease or nutrient issues. This machine has a great deal of potential for growers as well as researchers.