

UAV-based Multispectral Imaging for High-throughput Phenotyping of Dry Bean Breeding Trials

K.D. Singh¹, P. Balasubramanian¹, M. Natarajan¹, H. Wang¹, and P. Ravichandran¹

¹Agriculture and Agri-Food Canada (AAFC), Lethbridge Research and Development Centre

November 27, 2023



UAV-based Multispectral Imaging for High-throughput Phenotyping of Dry Bean Breeding Trials

Singh, K.D.^{1†}, Balasubramanian, P.¹, Natarajan, M.¹, Wang, H.¹, and Ravichandran, P.¹

¹Agriculture and Agri-Food Canada (AAFC), Lethbridge Research and Development Centre, Lethbridge, AB, Canada

Keywords: Dry bean, plant breeding, digital imaging, phenotyping, functional traits

Abstract:

Dry bean (*Phaseolus vulgaris* L.) is the third largest pulse crop grown in Canada. Due to climate change and extreme weather, dry bean varieties are subjected to abiotic and biotic stresses, which affect yield stability and seed quality. Development of resilient cultivars is the most effective strategy to ensure productivity and environmental sustainability of dry bean crop. In this project, key phenotypic traits will be extracted for genetic improvement and development of elite cultivars with early maturity and high yield. Traditional phenotyping approaches are rigorous, time-consuming, and subject to human errors. Unmanned aerial vehicle (UAV)-based high-throughput phenotyping (HTP) has been changing the way of doing large-scale phenotyping in plant breeding. The use of aerial imaging systems offers a potential solution to provide an intensive tool for complex traits assessment to evaluate a large number of dry bean genotypes. By this, HTP technique will be optimized to improve selection efficiency of agronomic, physiological and disease resistance traits. In this study, two dry bean field trials, Advanced Yield Trial (AYT) consisting of F₇ generation [yellow bean (5 entries), Pinto bean (20 entries)], and Performance Yield Trial (PeYT) of F₈-F₁₀ generation (49 entries) were grown in a randomized-block design at the Fairfield Research Farm at AAFC Lethbridge, AB. Both field trials were imaged at the specific developmental stages (vegetative, flowering, maturity) using UAV mounted RGB and multispectral sensors. The acquired imagery have been processed to accurately overlay images from different dates (time-series data comparison). We analyzed three-time point RGB and multispectral images to identify valuable traits such as canopy height, crop lodging, physiological maturity and accumulation of crop biomass over time. With the preliminary results, we found the utilization of UAV-based HTP has significant advantage in non-destructive measurements of canopy-level functional traits. Assessment of these traits at same climatic region can be used to identify crop characteristics that are important for screening of high-quality dry bean experimental lines and cultivars in field conditions. In the long term, it will provide a consistent and reliable information system to rapidly screen thousands of breeding populations individually that need to be genotyped for morphological and physiological functional traits.

Acknowledgement: Field and technical support by AAFC staff at Lethbridge is greatly appreciated. It mainly include Todd Reid, Steph Kinnee and Crystal Rushka from the dry bean breeding program. This project is funded by Alberta Pulse Growers Commission, and AAFC through Sustainable Canadian Agricultural Partnership (S-CAP).

[†]Corresponding author: Keshav Singh (keshav.singh@agr.gc.ca)