Using drones for high resolution field-scale trial monitoring in potatoes

Introduction

Traditional methods of counting plants and analyzing spacing are laborious and result in significantly lower sample numbers compared to those carried out using drones and image processing software. In this study from Prince Edward Island, Canada in 2021-2023, drones were used to capture high resolution imagery in several fields with plant spacing trials. Drones were able to accurately measure plant spacing and canopy cover with large sample sizes. This information was used to develop conclusions from field trials that involved planter performance assessment and several treatments including variable rate seed spacing.

Objectives

- To assess the accuracy of drones in measuring plant spacing
- To determine ideal flight timing and recommended resolution for monitoring trials with drone imagery
- To develop practical ways of using information collected by drones to assess treatment efficacy in potatoes

Background

- Understanding characteristics such as plant spacing, consistency of spacing, and early season crop growth is useful for comparing treatment efficacy in field trials in potatoes.
- Traditional methods of data collection involve manual plant counts and canopy assessment, which are laborious and subjective.
- Drones can capture large quantities of high-resolution imagery, necessary for assessing individual plant characteristics. Imagery captured by satellite and manned aircraft is not capable of achieving such resolution.

Methodology

- 26 sites were surveyed by drone in Prince Edward Island, Canada between 2021 and 2023. These sites featured field trials comparing plant spacing treatments, planter speed treatments, and planter equipment modification treatments.
- Fields were surveyed with an eBee X and Duet T camera at 50m above ground level (AGL). This resulted in a ground sampling distance (GSD) of 1.2cm/pixel, which is suitable for individual plant analysis in potatoes in most cases. At this altitude, the drone could cover approx. 15 ha (37.5ac) with one battery.
- Imagery was stitched in Pix4D and uploaded to Picterra and Solvi software services for plant-by-plant identification. Row detection, plant spacing analysis, canopy cover analysis, and trial statistics were calculated using QGIS and Minitab software.
- To assess plant count accuracy, manual measurements were taken in the field at the same time as the drone survey with two-meter-long ground target strips used to identify measurement locations.

Figure 1: eBee X drone and Duet T Camera (AgEagle Aerial Systems, Inc.)

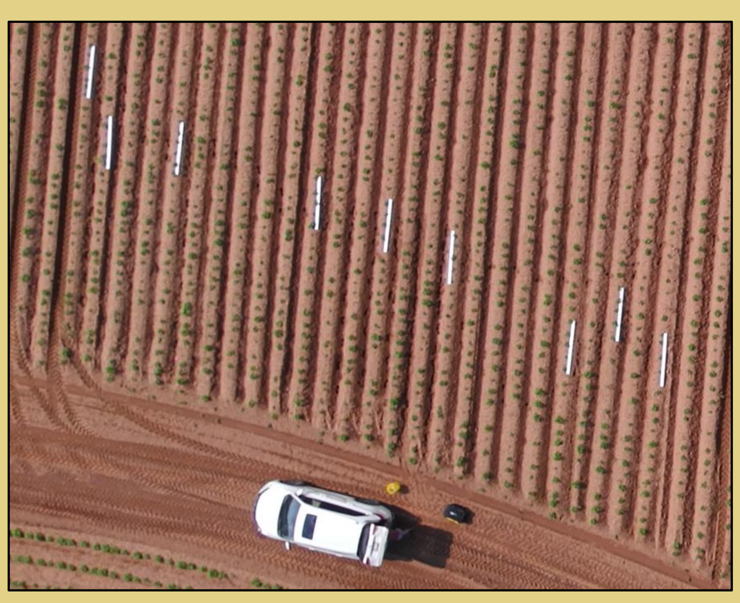

Figure 2: Drone imagery showing plants and target strips

Conclusions

- Drone-based imagery analysis accurately counted plants (100%) and estimated spacing (96%) vs manual methods. Using drone imagery should be considered as an evaluation tool in agronomic field trials in potatoes due to its accuracy and ability to collect large sample sizes. Affordable drones (<$2,000 CAD) can be used to capture imagery.
- Timing is critical in assessing plant spacing in potatoes and AI/ML models perform best when plants are large enough to easily be detected (100 cm^2) , but not overlapping each other. Image resolution should be 1.2 cm/pixel or greater. Tighter spacing may require higher resolution imagery.

Analysis and Results

Accuracy Assessment

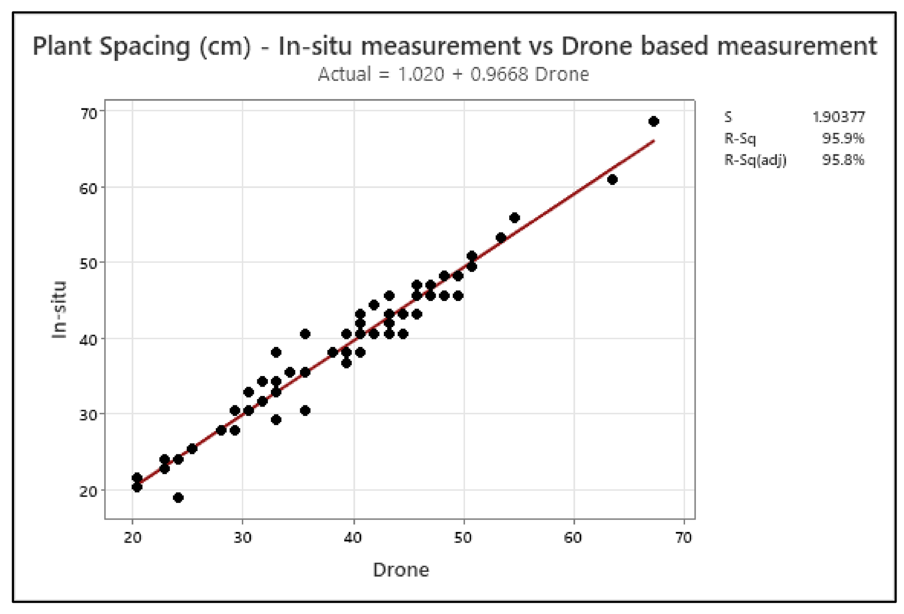

Figure 3: Fitted line plot with in-situ vs drone-based measurements

Drone-based spacing assessment was accurate when compared with measurements from the field. See ground target example and drone-based spacing estimates in Fig. 4

Figure 4: Drone based plant spacing and ground targets

Drone-based spacing measurements can be seen alongside the two-meter-long ground target used for capturing in-situ measurements

Examples of Drone based emergence analysis

1. Assessing planter performance

Site 1: Springfield West, PE Planter Accuracy Assessment			
Spacing Treatment (n)	Target Spacing (cm)	Measured Spacing (cm)	Difference
Tighter (28,908)	30.5	31.8	-4.0%
GSP (41,568)	35.6	35.1	1.0%
Wider (21,945)	40.6	38.6	4.9%

Site 2: Tryon, PE Planter Accuracy Assessment			
Spacing Treatment (n)	Target Spacing (cm)	Measured Spacing (cm)	Difference
Tighter (42,529)	19	22.5	-15.6%
GSP (111,074)	22.9	23.3	-1.7%
Wider (32,800)	26.7	25.2	6.0%

Site 3: Red Point, PE Planter Accuracy Assessment			
Spacing Treatment (n)	Target Spacing (cm)	Measured Spacing (cm)	Difference
Tighter (35,003)	35.6	34.5	3.1%
GSP (191,750)	40.6	39.9	1.7%
Wider (26,538)	45.7	45.2	1.1%

Figure 5: Measured spacing of emerged plants

This chart shows measured vs target spacing from a variable rate seeding trial carried out in 2021. Notice the large sample sizes

2. Comparing planter speed vs spacing

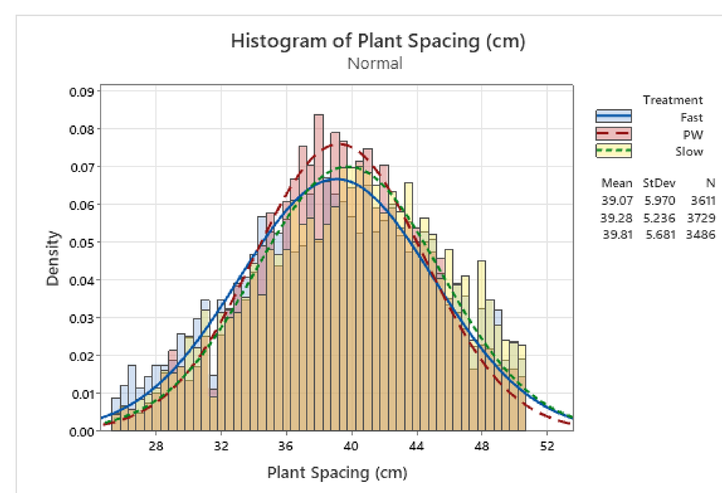

Figure 6: Histogram of plant spacing distribution

This graph shows plant spacing distribution comparing three planter treatments: Fast (6.4 km/h), Slow (4.8 km/h), and Fast with Press Wheel (6.4 km/h)

3. Measuring canopy cover

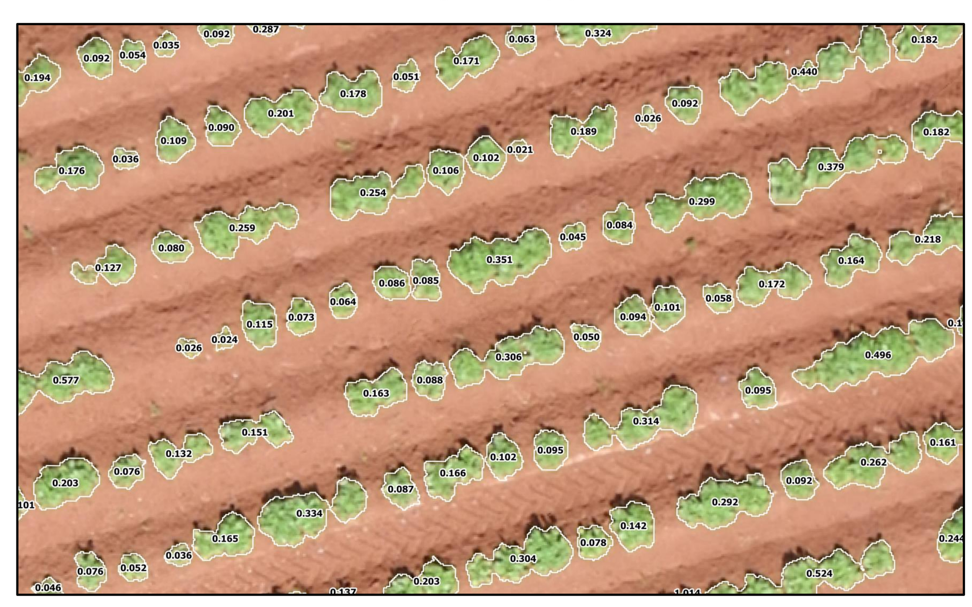

Figure 7: Canopy cover measurement (sq m)

It is possible to generate accurate calculations of canopy cover early in the season with high-resolution RGB drone imagery. This is a useful metric in comparing treatment efficacy.

4. Calculating statistics by management zone

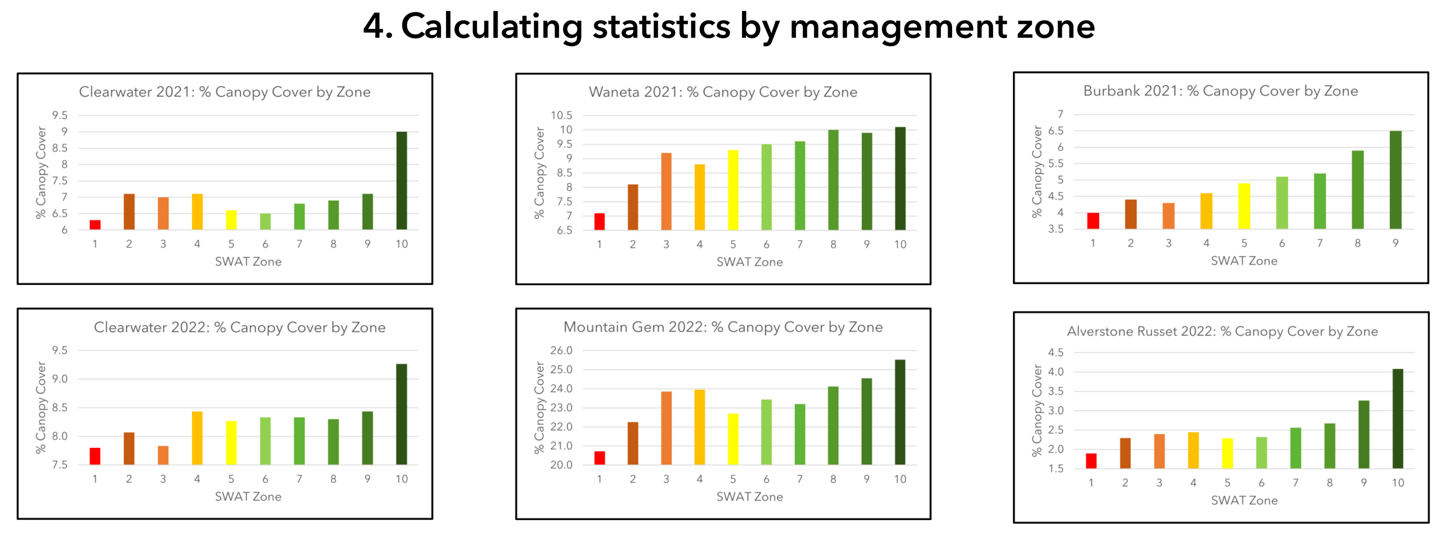

Figure 8: Canopy cover percentages by management zone

In this study, which assessed the impacts of variable rate seed spacing in potatoes, drone imagery was used to observe patterns in canopy cover by management zone. An interesting trend was revealed that showed lower landscape positions had more canopy growth early in the season. This trend followed through until the end of the year at harvest, where zones 7-10 yielded the best crop over six sites and two years. Intercepting sunlight, preventing weed growth, and conserving soil moisture are some of the benefits of early season canopy closure. This can be accurately measured at scale with high-resolution drone imagery.

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