Characterizing Cicer Milkvetch Populations Using Agro-Morphological & Drone-Based Traits

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Cicer milkvetch (*Astragalus cicer* L.) is a non-bloat perennial forage legume with a native range from Europe to Central Asia. Forage mixtures that include cicer milkvetch can provide high yields and high digestibility late in the growing season. The time and cost associated with characterizing populations of cicer milkvetch are some of the factors that have limited the advancement of this crop through plant breeding. Drone-based multispectral remote sensing could expedite the breeding of future cultivars of cicer milkvetch by characterizing a large number of populations in a short amount of time. The objectives for this research project were: 1) Characterize the growth of the cicer milkvetch populations Veldt, PI 362241, and PI 206405 from early June to mid-October using measurements of maximum stem length, plant area rating, NDVI green area, and NDVI canopy volume and 2) Identify drone-based traits with significant correlations to forage dry matter yield (FDMY) at forage harvest dates in late June and mid-October. A completely randomized nursery with three replications per population was established near Clavet Saskatchewan in 2019. Twenty-five diverse populations of cicer milkvetch from the USDA Genebank were compared to two Canadian cultivars Veldt and AC Oxley II. Data was collected from these populations approximately every two weeks from early June to mid-October in 2020 and 2021 for a total of nine dates per growing season. Two agro-morphological traits maximum stem length and plant area rating were examined at each date along with drone-based traits green area and canopy volume using NDVI. FDMY was measured on June 30th and October 15th of each year to simulate the two harvest times of a stockpile grazing system. The populations Veldt, PI 362241, and PI 206405 were consistently ranked as high, medium, and low performing respectively based on the two agro-morphological traits and two drone-based traits that were measured throughout the growing season. This ranking was consistent with the FDMY of these three populations at both the first and stockpile harvests. Polynomial regression of each population indicated that the two agro-morphological traits and two drone-based traits commonly developed in a linear fashion. Growth was more rapid in June up to the first harvest as indicated by a higher slope when compared to leading up to the stockpile harvest. Of the agro-morphological traits, maximum stem length had the highest correlation with FDMY at both harvest times with Pearson's correlation coefficients (PCC) equal to 0.69 and 0.60 at the first and the stockpile harvests respectively. NDVI green area was most highly correlated with FDMY among the drone-based traits with PCC of 0.92 and 0.66 at the first and stockpile harvests, respectively. These results demonstrate that some of the selected agro-morphological traits are highly correlated with the FDMY of cicer milkvetch. Drone-based traits such as NDVI green area have the potential to be used as a tool for the selection of high yielding cicer milkvetch populations. Current limitations to the adoption of this technology include the time needed for image processing and differentiating populations of similar performance levels due to high intra-population variability.