Applicability of low altitude multispectral sensing towards crop and site specific adaptation of LESA

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Abstract

Water is one of the most valuable resource of the western states and is the foundation for a multi billion-dollar agricultural industry. Washington State is marked by a very diverse climatic and topography conditions. Thus, keeping in view the present situation of water and future needs under a changing climate, growers need to adopt new/improved irrigation technologies, like Low Elevation Spray/Precision Application (LESA/LEPA). Such technologies have grower adoption concerns related to water use efficiencies as the effects on canopy and air temperature driven evapotranspiration are unknown. Therefore, this study focuses on evaluating LESA and compare it with performance of Mid Elevation Spray Application (MESA) using small unmanned aerial system (UAS) integrated multispectral and thermal imaging. The field experiments were designed to have two adjacent sub-sections of a center pivot sprinkler irrigation system with both LESA and MESA, which irrigated a potato crop throughout the 2015 season with approximate nozzle heights of 0.45 m and 2.1 m, respectively. Small UAS based imagery acquired during mid-growth stage was analyzed using custom developed image processing algorithms in Pix4D® and ArcGIS®. Multispectral data was analyzed to extract Green Normalized Difference Vegetation Index (GNDVI) whereas thermal infrared data was analyzed to generate thermal index maps of the study area. Zonal means based on the regions of interest within the study area showed lower GNDVI (0.14±0.031) [mean±std. dev.] for MESA compared to LESA (0.30±0.032). This suggested high crop vigor for LESA irrigated sections. Similarly, canopies were about 2°C cooler when irrigated with LESA compared to MESA. The spatial maps showed the applicability of using small UAS based multi-spectral and thermal imagery in studying suitability of LESA at the given potato field site. Future studies are planned to relate the aerial imagery data with ground reference data for potato and mint crops and also investigate crop canopy and associate microclimate attributes temporarily throughout 2017 season.

Introduction: Being the most precious resource, water availability and management is of prime importance. Water shortage influences the WA states agriculture. With the mission to ensure water accessibility stakeholders should think out of the box and measures must be taken for the management of water.

Water management simply defines, the best efficient use of available water. Agricultural water management is dependent on the irrigation methods and systems used. Pressurized irrigation methods hold promising water saving history. Sprinkler irrigation with 75-85% irrigation efficiency has enough aspects in the sense of system design, orientation and selection that must be considered to increase the efficiency.

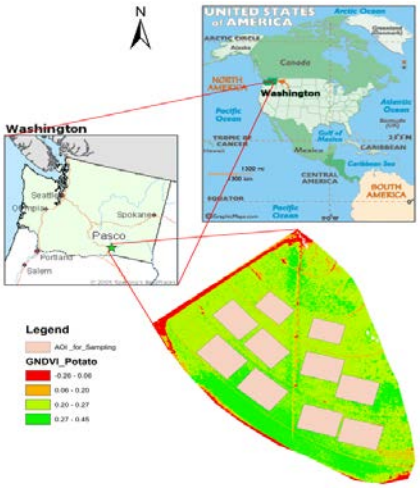

Fig. 1 Study area

The objective of the current study focuses on the evaluation of different sprinkler height settings and resulting improve water use efficiency in potato production.

Fig. 2 Sampling point and GNDVI

Methodology: A field site was selected in the Pasco area as shown in Fig. 1. Data acquisition was completed using small UAS (ARF OktoXL 6S12, HiSystems GmbH, Moormerland, Germany)platform equipped with a thermal infrared camera (model: Tau 2 640,FLIR® Systems, Wilsonville, Oregon, USA), and a multispectral digital camera (model: NiteCanon ELPH110 LDP LLC, Carlstadt, New Jersey, USA) with, red (R), green (G), and near infrared (NIR, 800-900 nm) bands (Figure 2). These data sets were analyzed using custom developed image processing algorithms in Pix4D® and ArcGIS® for estimating crop vigor (GNDVI) and canopy stress (temperature). Using random sampling of field imagery, the GNDVI/temperature data on both the LESA and MESA before irrigation and after irrigation were extracted to infer the treatment effects.

Results summary: Zonal means based on the regions of interest within the study area showed lower GNDVI (0.14±0.031) for MESA compared to LESA (0.30±0.032). This suggested high crop vigor for LESA irrigated sections. Similarly, canopies were about 2°C cooler when irrigated with LESA compared to MESA. The spatial maps showed the applicability of using small UAS based multi-spectral and thermal imagery in studying suitability of LESA at the given potato field site.

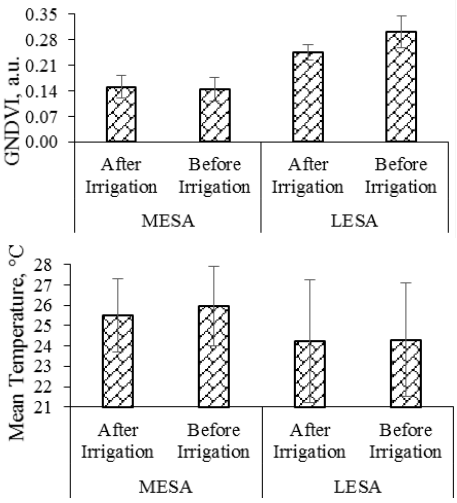

Fig. 3a & b Comparison of canopy vigor and temperature variation (MESA vs LESA)

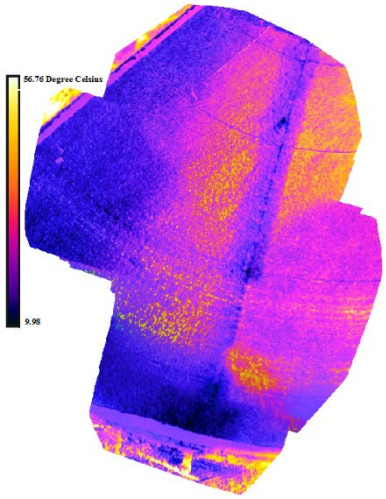

Fig. 4 Spatial distrubution of canopy temperature in treatment blocks

Future Studies: Future studies are planned to relate the aerial imagery data with ground reference data for potato and mint crops and also investigate crop canopy and associate microclimate attributes temporarily throughout 2017 season.