Low Energy Precision (/Spray) Applications: Unmanned Aerial System based Rapid Evaluation for Crop and Site Specific System Adaptation in the Pacific Northwest

Basic Information

Title:	Low Energy Precision (/Spray) Applications: Unmanned Aerial System based Rapid Evaluation for Crop and Site Specific System Adaptation in the Pacific Northwest
Project Number:	2016WA412B
Start Date:	3/1/2016
End Date:	12/31/2017
Funding Source:	104B
Congressional District:	5
Research Category:	Engineering
Focus Category:	Irrigation, Agriculture, Water Use
Descriptors:	None
Principal Investigators:	Lav R Khot, Troy Peters

Publications

1. Sarwar*, A., L. R. Khot, and R. T. Peters. 2017. Applicability of low altitude multispectral sensing towards crop and site specific adaptation of LESA. Climate Impacts to water conference, Skamania Lodge, Stevenson, WA. January 25-26, 2017 (Paper/Oral Presentation). Link: http://ext100.wsu.edu/water/wp-content/uploads/sites/53/2017/01/Abid-Sarwar-USE-THIS-ONE-Proceeding-F
2. (Upcoming) Khot*, L., M. A. Khan, M. Chakraborty, and R. T. Peters. 2017. Low altitude multispectral sensing based evaluation of retrofitted center pivot irrigation systems for site specific adoption in Potato and Mint production. ASABE 2017 Annual International Conference Meeting, Spokane, WA, July 16-19, 2017.
3. (Upcoming) Osroosh*, Y., L. R. Khot, and R. T. Peters. 2017. Web-based crop monitoring system for performance evaluation of center pivot irrigation retrofitted with MESA and LESA. ASABE 2017 Annual International Conference Meeting, Spokane, WA, July 16-19, 2017.

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L. R. Khot and R. T. Peters, Washington State University, WA; H. W. Neibling, University of Idaho, ID.

Abstract:

Irrigation of agricultural crops is by far the largest use of water in the arid West. Amidst rapidly changing climatic conditions, water has become a valuable resource for use in diverse agricultural cropping systems in Washington State. Thus, growers need to adopt new/improved irrigation technologies, like Low Elevation Spray/Precision Application (LESA/LEPA) for improved and efficient water use. Such techniques have been practiced successfully for years in the Texas Panhandle and Kansas areas; however, have grower adoption concerns in Pacific Northwest. Key criticisms is that the real efficiency differences between LESA and Mid Elevation Spray Application (MESA) are overestimated since the water that is lost to wind drift and evaporation from MESA suppresses crop water use requirements downwind. To help quantify these differences, it is important to measure canopy temperature differences of similar crops. This data would help show where the additional energy is either lost or gained from evaporated water. Therefore, this project focuses on evaluating LESA and compare it with performance of MESA using small unmanned aerial system (UAS) integrated multispectral and thermal imaging. Our 2016 preliminary trials in potato had sown promising results. Small UAS based imagery was acquired during mid-growth stage and developed were the zonal maps. Lower potato crop vigor (Green NDVI of 0.14±0.03) was observed for MESA compared to LESA (0.30±0.03). Similarly, canopies were ~2°C cooler when irrigated with LESA compared to MESA. On-going 2017 season experiment campaigns will thus critically assess LSEA and MSEA using small UAS based remote sensing approach and utilize such data in effective extension/outreach of pertinent outcomes.

Brief description of project:

Our project objective is to collect UAS based infrared and multispectral (images) sensing data to effectively quantify the performance of the demonstration fields where we have LESA vs MESA, and LEPA vs MESA systems. Such comparative sites are throughout the state of Washington, Idaho, Nevada, and Oregon. This study will specifically focus on performance evaluation of the demonstration fields in Washington and Idaho.

Project status summary:

In 2016, our team integrated small UAS with the multi-spectral (5-band) and thermal infrared (with capability to have pixelated temperature) sensors for use on this project. Test flights were conducted to optimize the flight parameters and image acquisition protocols. Preliminary trials were conducted in potato crop where the sections of irrigation circle (central pivot) was retrofitted for LESA. Small UAS based imagery was acquired during mid-growth stage. Such imagery was then post-processed using custom developed data processing algorithms to develop the zonal maps. Our team has planned extensive data campaigns for on-going 2017 season where we will evaluate several irrigated crops (mint, alfalfa, beans and wheat). Experiment campaigns

will thus critically assess LSEA and MSEA using small UAS based remote sensing approach and utilize such data in effective extension/outreach of pertinent outcomes.

Results summary (to date and expected results)

Results to date: In 2016, we have integrated small UAS based imaging system. Preliminary trials data revealed lower potato crop vigor (Green NDVI of 0.14±0.03) for MESA compared to LESA (0.30±0.03). Similarly, thermal infrared data suggested that potato canopies were ~2°C cooler when irrigated with LESA compared to MESA.

Expected results: Small UAS based imagery data will aid us in evaluation of how the wetted canopy affects application efficiency, how it may suppress evapotranspiration demand, and it can also be used to see differences in ponding and runoff from the LESA/LEPA and MESA. High resolution images will also supplement physical demonstrations of the LEPA/LESA system and to assuage grower fears of the potential drawbacks of this technology. UAS based high resolution (5-band multi-spectral and thermal infrared sensors) imaging at various crop growth stages (minimum two) will enable our team to quantify the canopy health and water use efficiency for the sites irrigated with LESA/LEPA vs MESA.

Updated timeline of completion:

- Graduate student training (Fall 2016 through Spring 2018)
- Develop/optimize UAS-based remote sensing protocols (Summer, Fall 2016)
- Field data collection (WA & ID field sites) (Summer 2016; Summer & Fall 2017)
- Final Project Report submitted to the WRC (15 December 2017)
- Image analysis algorithms development; data analysis & mapping, peer-reviewed manuscripts (Fall 2016; Spring 2017 through Spring 2018)
- Extension and outreach (Fall 2016; Fall 2017)
- Develop federal grant proposals (Ongoing efforts; extend beyond project period)

Outcomes/Impacts to date:

1) References for any journal articles under review, accepted, or published that this grant supported,

N/A

2) Any presentations or talks relating to this work

Sarwar*, A., L. R. Khot, and R. T. Peters. 2017. Applicability of low altitude multispectral sensing towards crop and site specific adaptation of LESA. Climate Impacts to water conference, Skamania Lodge, Stevenson, WA. January 25-26, 2017 (Paper/Oral Presentation). Link: http://ext100.wsu.edu/water/wp-content/uploads/sites/53/2017/01/Abid-Sarwar-USE-THIS-ONE-Proceeding-Paper-2017_f.pdf

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3) Provide the number of Ph.D., Masters, and/or undergraduate students supported by this grant

PhD: 1 (Abid Sarwar, Fall 2016); MS: 1 (Momtanu Chakraborty, *partly supported*)