

**POTATO YIELD AND QUALITY RESPONSE TO REDUCED
IRRIGATION WATER USE FOR EARLY AND MEDIUM
MATURITY CULTIVARS**

(2nd Year Study)

**RESEARCH PROPOSAL FOR COLORADO CERTIFIED POTATO
GROWERS ASSOCIATION (CCPGA) ROYALTY FUNDS**

2015

SUBMITTED BY

**SAMUEL Y.C. ESSAH
ALLAN A. ANDALES
TROY BAUDER**

Project Title

Potato Yield and Quality Response to Reduced Irrigation Water use for Early and Medium Maturity Potato Cultivars.

Funding Source

Colorado Certified Potato Growers Association (CCPGA) – CSU Cultivar Royalty Funds

Investigators

1. Samuel Y.C. Essah, Potato Cultivar Management and Physiology, Colorado State University, Department of Horticulture and Landscape Architecture, San Luis Valley Research Center
2. Allan A. Andales, Irrigation and Water Science Colorado State University, Department of Soil and Crop Sciences, Fort Collins
3. Troy Bauder, Water Quality and Management Colorado State University, Department of Soil and Crop Sciences, Fort Collins

Nature and Scope of Proposed Research

This field study was started in 2014 with very successful results. A second year study is being proposed to validate the results.

Irrigation is required for profitable potato production in Colorado. In recent years, water availability for potato production has been restricted due to the dwindling water table. When restricted water availability reduces potato production potential, options for increasing water use efficiency need to be considered.

Research has shown that potato tuber yield and quality will be impacted by even short periods of water stress. The extent of damage to tuber yield and quality will depend on the severity, timing, and duration of water stress during the growing season. Studies have shown that water stress during tuber set and early bulking growth stages causes the greatest reductions in tuber yield and quality relative to other growth stages. Water deficits spread over the latter part of the growing season generally have less impact on tuber yield and quality, than an equivalent reduction in crop water use over a short period of time. Such managed irrigation acts as a means of sustaining economic yields while reducing consumptive water use.

The choice of potato cultivar can be an important tool in dealing with reduced irrigation for potato production. Potato cultivars vary widely in maturity and in ability to withstand water stress. One or both of these traits can help with avoidance of serious losses in reduced water situations.

In this project, Samuel Essah will also collaborate with two water science faculty (Co-Principal Investigators, Co-PIs) from the Department of Soil and Crop Sciences, Colorado State University, to demonstrate and validate the use of a new online irrigation scheduling tool for potato production in the San Luis Valley. The primary goal of this

part of the project will be to assess the utility and accuracy of the online irrigation scheduling tool for potato production. The irrigation scheduler's calculations for crop water use have been calibrated in northern Colorado for corn and alfalfa, but the need remains for validation in potatoes. This project will provide the opportunity for the online irrigation tool to be validated for potato production in the Valley.

Objectives of Proposed Research

This proposal seeks to optimize the amount of water that is used to irrigate potatoes in the San Luis Valley. The specific research objectives of our proposal are:

1. Evaluate the effect of reduced irrigation water use on yield and quality of early and medium maturity potato cultivars.
2. Demonstrate the use of an online irrigation scheduler for potato production in the San Luis Valley.

Experimental Methodology

Objective 1. Evaluate the effect of reduced irrigation water use on yield and quality of early and medium maturity potato cultivars.

Experimental Site

The field study will be conducted at the San Luis Valley Research Center, Colorado State University, during the 2015 potato growing season.

Experimental Design and Treatments

The study will be laid out as a factorial arrangement of treatments in a randomized complete block design.

Treatments will include three deficit irrigation scenarios, (1) Application of irrigation water to provide 100% ET replacement for the full season (2) Providing 100% ET replacement until late tuber bulking, and then applying 90% ET replacement for the rest of the season (3) Providing 100% ET replacement until late tuber bulking, and then applying 80% ET replacement for the rest of the season. Early and medium maturity potato cultivars will be evaluated under the three irrigation scenarios. Each treatment will be replicated four times.

Data Collection

Leaf Area Index, Tuber Bulking, and Harvest Index

Plants will be sampled from each plot during the latter part of tuber bulking, after reduced irrigation treatments have begun. Leaf Area Index will be measured weekly for sampled plants to determine the effect of reduced irrigation on Leaf Area Duration. Potato tubers from sampled plants will be evaluated for tuber bulking as influenced by reduced

irrigation. Harvest Index (HI), which is a measure of how efficient the plant is able to translocate photosynthate to the tubers will be evaluated in this study. The effect of the treatments on tuber set and stem number will also be evaluated in this project.

Tuber Yield and Tuber Size Distribution

At harvest, tubers from each plot will be weighed for total yield. The harvested tubers will be separated into various size distribution groups based on weight (<4 oz., >4 oz., >6 oz., 4-10 oz., >10 oz., 4-16 oz., and >16 oz.), and tuber diameter (<2 inches (in.), >2 in., >2 in.<10 oz., and >2 in.>10 oz.), to determine the effect of reduced irrigation on tuber size distribution.

Tuber Quality

Tubers harvested from each plot will be evaluated for external (growth cracks, knobs, and misshapes), and internal (Hollow Heart and Brown Center) defects. Ten large tubers will be randomly selected from each plot for tuber specific gravity evaluation. Tuber specific gravity will be measured by using the weight-in-air/weight-in-water method.

Objective 2. Demonstrate and validate the use of an online irrigation scheduler for potato production in the San Luis Valley.

In order to validate information provided by the scheduler, soil moisture instruments will be installed and gravimetric soil moisture will be taken weekly. Daily alfalfa reference evapotranspiration (ET_r) calculated using weather data from the CoAgMet weather station installed at the San Luis Valley Research Center will be used with potato crop coefficient curves to estimate daily potato crop ET (ET_c). The estimated ET_c values will be used in the online irrigation scheduler along with rainfall data from CoAgMet and actual applied irrigation to calculate the daily soil water content and irrigation water requirement of potato fields. Co-PIs from the irrigation and water unit of the Department of Soil and Crop Sciences will visit the project site three times during the growing season. The purpose of the visits will be to compare soil moisture data collected to the irrigation scheduler output. These comparisons will help calibrate the potato crop coefficient curves for local conditions.

How this Project Will Enhance Colorado Potato Grower Competitiveness

A positive response of the cultivars to reduced irrigation water use will indicate that growers can reduce irrigation water for optimum potato production in the San Luis Valley. This will help reduce or alleviate the issue of water shortage for irrigation during the latter stages of potato growth and development. Electrical energy for operating irrigation equipment will reduce, thereby reducing overall input cost as well as saving irrigation water for potato production. Validation of the online irrigation scheduler for potato production in the San Luis Valley will provide an irrigation water management

tool that can guide potato growers in making tactical irrigation decisions during the growing season.

Extension-Outreach Plan for Reporting Project Information to Growers

A field day will be organized in August for growers to visit the research site, and to see the effect of reduced irrigation on potato crop growth and development.

A summary of the results gathered from this project will be presented at the Southern Rocky Mountain Agricultural Conference in Monte Vista. Project results will be posted on the Colorado State University potato program website, posted on the Colorado State University main website, and on the San Luis Valley Research Center Website.

Potato growers in the San Luis Valley will have the opportunity to use the online irrigation scheduler (with project member support) and provide feedback on improving the tool throughout the growing season.

Potential for Results to Leverage Additional Outside Funding

This project will provide preliminary data for the submission of proposals to agencies such as the USDA-Natural Resource Conservation Service and Western SARE for water use efficiency research funds.

Timeline and Expected Short Term (one year) and long Term (3-5 years) Outcomes

This project will begin in May, 2015, and will continue until February, 2016.

Timeline – 1 Year

ACTIVITY	DATE
Field preparation	April, 2015
Potato seed cutting and preparation	Early May, 2015
Planting	Mid May, 2015
Plot management and data collection	June – September, 2015
Harvest	Late August – middle of September, 2015
Grading, Sizing, and quality evaluation	October – November, 2015
Data Analysis and summary	December, 2015
Report writing	January, 2016
Presentation of results to potato growers	February, 2016

For the longer term (3-5 years), other potato cultivars that include long term maturity groups will be tested to evaluate their response to reduced irrigation water use.

ANNUAL BUDGET

Personnel

Help from a Research Associate and two non-student aids will be needed to get the field and laboratory studies completed successfully.

Partial salary for a Research Associate and wages for two aids in the San Luis Valley,
plus fringe benefits = \$14,700.00
Salary for Co-PIs Technician in Fort Collins to analyze data = \$ 5,000.00

Total Wages and Fringe Benefits for Personnel \$19,700.00

Materials and Supplies

1. Potato sacks, gloves, masks, sample paper bags,
field stakes, flags, and scissors \$ 300.00
2. Supplies for Co-PIs in Fort Collins \$ 500.00

Total Materials and Supplies \$ 800.00

Services

Soil and water analysis before planting \$ 300.00

Total Services \$ 300.00

In-State Travel

Co-PIs travel from Fort Collins to project site (3 times) \$1,800.00

Total In-State Travel \$1,800.00

Total amount of this request \$22,600.00

Budget Justification

Wages for Personnel:

Because of the extensive field and lab work involved in this study, such as soil sampling, seed cutting, potato planting, digging holes to bury water and temperature sensors, in-season field management and data collection (whole plant sampling), fertilizer application before and during the growing season, potato harvest, sizing and grading, data compilation and analysis, considerable financial resources are committed to personnel. Fourteen thousand seven hundred dollars (\$14,700.00) is being requested for wages and fringe benefits for personnel in the San Luis Valley, and five thousand dollars (\$5,000.00) for Co-PIs Technician in Fort Collins to help in data analysis.

Materials and Supplies:

Field supplies include items such as field stakes, flags, sample paper bags, gloves, masks, scissors, and potato sacks for harvesting. Three hundred dollars is requested for field supplies in the San Luis Valley, and five hundred dollars is being requested by Co-PIs for supplies from Fort Collins. A total of eight hundred dollars (\$ 800.00) is being requested for materials and supplies in this budget.

Services:

Soil samples will be taken from each experimental plot before planting. Water samples will also be taken from the irrigation well. All samples collected will be sent to a soil, water, and plant nutrient analytical lab for analysis. Three hundred dollars (\$300.00) is being requested for shipment and payment of sample analysis.

In-State Travel:

One thousand and eight hundred dollars (\$1,800.00) is requested in this budget for travel and lodging for Co-PIs, who will travel from Fort Collins to visit the project for data collection. Co-PIs are estimated to travel to the project site three times during the potato growing season.

**Drip Irrigation Project in the San Luis Valley. In Cooperation with Mountain King,
Netafim, and Colorado Potato Administrative Committee**

**Data Collection by Colorado State University Scientists
2015 Budget Request**

Personnel to be involved in data collection:

1. Samuel Y.C. Essah, Ph.D.
Associate Professor and Extension Specialist, potato crop management and physiology,
Department of Horticulture and Landscape Architecture, Colorado State University,
San Luis Valley Research Center
2. Allan A. Andales, Ph.D.
Associate Professor and Extension Specialist, Irrigation and Water Science, Department
of Soil and Crop Sciences, Colorado State University, Fort Collins
3. Troy Bauder
Senior Research Associate/Extension Specialist, Department of Soil and Crop Science,
Colorado State University, Fort Collins
4. Jose L. Chavez, Ph.D.
Assistant Professor and Extension Specialist, Irrigation Engineering and Water
Management, Department of Civil and Environmental Engineering, Colorado State
University, Fort Collins.

Supplies and Budget

Samuel Y.C. Essah

Samuel Essah will visit the study site with his field crew at least once a week to monitor crop growth and development under the two irrigation systems. The following data will be collected during the 2015 crop growing season:

1. Canopy development (Leaf Area Index/Leaf Area Duration)
2. Plant dry matter yield (leaf, stem, tuber)
3. Petiole nutrient concentration profile during the growing season (Complete analysis)
4. Tuber bulking rate
5. Tuber yield and tuber size distribution
6. Tuber Shape (Tuber diameter and tuber length).
7. Tuber quality: a) External defects (growth cracks, knobs, misshapes)
b) Internal defects (hollow heart, brown center)
c) Tuber specific gravity

Ten thousand dollars (\$10,000.00) is being requested for partial salary of a Research Associate, two non-student hourly aid, and cost of plant nutrient analysis.

Allan A. Andales and Troy Bauder

Allan and Troy will monitor soil water balance and measure crop evapotranspiration (ET) in this project.

Flow meters will be needed on the center pivot sprinkler and drip irrigation systems. There will be on-site recording rain gauge. Eight soil sensors and two data loggers will be needed.

An hourly undergraduate student will visit the plots every two weeks to down load data from the loggers, take gravimetric soil samples, and overhead photos of potato crop canopy. The hourly student will also perform data processing and analysis of soil water, soil temperature, EC, canopy cover, and estimated ET.

Budget

Budget - Potato drip irrigation study (water balance monitoring)

Item	#	Rate (\$)	\$
Mileage (miles)	5400	0.50	\$ 2,700.00
Lodging/per diem	10	\$ 150.00	\$ 1,500.00
Labor (hours)	400	\$ 12.50	\$ 5,000.00
<i>Equipment/Supplies</i>			
Decagon 5TE sensor	8	\$ 243.00	\$ 1,944.00
Decagon Em50 logger	2	\$ 480.00	\$ 960.00
AA Batteries (multi-pack)	2	\$ 15.00	\$ 30.00
Soil sample cans	24	3.00	\$ 72.00
Total			\$ 12,206.00

Jose Chavez

Dr. Jose will estimate the amount of water evapotranspired. One Large Aperture Scintillometer (LAS) will be installed to measure sensible heat flux (H) over the drip irrigation treatment. An air temperature and wind speed profile tower (APT) will also be installed.

The following supplies will be needed:

Two net radiometers (Rn), soil heat flux plates (SHFP), and soil temperature probes.

Budget

UAV operation costs (FAA COA paperwork, UAV data acquisition and processing, UAV partial liability insurance) - \$3,600.00

Travel - \$1,600.00

Total = \$5,200.00

Total Request for 2015 Project Data Collection = \$27,406.00