Quantification of industrial hemp CU rates, THC levels, weed pressure, and disease effects under irrigated conditions in Western Colorado

Perry Cabot

Title: Quantification of industrial hemp CU rates, THC levels, weed pressure, and disease effects under irrigated conditions in Western Colorado

Principal Investigator: Perry Cabot, Research Scientist III, Colorado Water Center, CSU Extension and Agricultural Experiment Station, (719) 334-2558
Email: perry.cabot@colostate.edu

Project Type: Water Research Grant Program

Keywords: hemp, consumptive use, drip irrigation, hemp disease

Location: This project will be collaborative between two participating research locations within the CSU Agricultural Experiment Station system.

Abstract: While some Colorado farmers have been cashing in the demand for hemp, research questions still abound on the viability for this crop to both conserve water regionally, and still also generating positive returns for farmers. This project will equip two research stations with necessary metering/monitoring equipment to supply a CU rate for optimally irrigated conditions. Additional evaluation will be performed on important hemp yield and THC levels for hemp crops grown under optimally and sub-optimally irrigated conditions. Weed biomass development will be evaluated on hemp fields on optimally and sub-optimally irrigated systems using subsurface drip irrigation (SDI), lay-flat drip irrigation and furrow irrigation. Finally, disease pressure (e.g., curly top virus) will be evaluated on drip irrigated fields using both black and reflective plastic "mulch" covering. Given that all of the researchers involved have some degree of Extension appointment, an ongoing engagement approach will be conducted as well.

Statement of water problem. With the majority of Colorado water rights used for agriculture, the next generations of farmers will face the pressing issue of increasing the conservation and efficiency of water use. Widely touted as a drought-resistant plant, hemp has been heralded as a new crop that offers alternative to many of the traditional agricultural markets that farmers currently access. Farmers throughout Colorado seek clarity on irrigation practices for hemp, while the concept of using this crop as a water-conserving alternative speaks to the need for understanding its consumptive use (CU) rates against other crops currently grown in the state.

Statement of the results or benefits. The influx of farmers new to hemp cultivation means there is a significant lack of farming experience on growing this relatively new crop to Colorado. The results and benefits of this research will be to supply necessary information on hemp irrigation practices and CU rates. Together, the information on these topics will benefit water resource managers at regional and district scales to better understand the water demand of this crop. Additional information will also be provided to clarify the impacts and benefits of different irrigation systems on both weed pressure and disease resistance.

Nature, scope, and objectives of the project, including a timeline of activities. This project will be conducted at two locations on in the Western Region of Colorado. In the Uncompahgre Valley, it is estimated that the 2019 cropping season witnessed approximately 10% of its irrigated acreage being planted to hemp, representing a marked increase from prior years. The scope of his project will entail the measurement of CU rates and associated hemp management practices during the May, June, July, August and October months of a cropping season, Specifically, the objectives of the project are as follows:

1. Two research sites will be planted to industrial hemp[1] and equipped with necessary metering/monitoring equipment to supply a CU rate for optimally irrigated conditions.
2. Yields and levels of THC in hemp crops will be evaluated under optimally and sub-optimally irrigated conditions.
3. Weed biomass development will be evaluated on hemp fields on optimally and sub-optimally irrigated systems using subsurface drip irrigation (SDI), lay-flat drip irrigation and furrow irrigation.
4. Disease pressure (e.g., curly top virus) will be evaluated on drip irrigated fields using both black and reflective plastic "mulch" covering

Timeline. Given the fiscal cycle of the CWC funding source, hemp start plants will be grown indoors at the Orchard Mesa Research Center, starting approximately 6-8 weeks before field transplanting. Recommendations on planting date vary for hemp in the Grand Valley versus Southwestern Colorado, but plants will be transplanted in late May and early June. Prior to planting, the drip irrigation systems will be placed and tested. Monitoring and metering equipment will be installed as soon as funding is available. Evaluations of CU rates will be ongoing throughout the season, while THC levels, weed pressure and disease effects will be evaluated at strategic times during plant growth stages.

Methods, procedures, and facilities. Hemp fields will be planted on SDI, lay-flat and furrow-irrigated fields in the Grand Valley and Southwestern Colorado. These facilities both have the necessary infrastructure to irrigate using these types of systems. A soil water balance approach will be used to evaluate CU rates for hemp under optimal irrigation conditions, using algebraic closure to determine CU as a function of ET. The water balance will be calculated by maintaining ongoing detailed monitoring of soil moisture in several field locations and plots (for replication) and measuring irrigation rates fields using at totalizing flow meter. It is expected that the use of drip irrigation will allow for highly efficient irrigation rates eliminate tailwater and deep percolation, while minimizing capillary rise. Optimal irrigation rates will be defined as those that maintain soil moisture levels in the root zone above management allowable depletion (MAD), while sub-optimal conditions will be imposed by allowing soils to drop below a prescribed MAD. A small lysimeter evaluation using growth pots will also be conducted. Furrow irrigation will be performed in accordance with local practices for number of sets, timing, etc. Leaf area index (LAI) will also be measured at regular times during the cropping season. Weed pressure will be evaluated by measuring biomass. Disease will be evaluated on the basis of plants affected and presence of the leafhopper bug, know to be the primary vector for carrying this virus. Dependent variables such as THC will be measured at various plant growth stages, using approved laboratory analyses (Aurum Labs, Durango, CO).

Related research. Some research studies have already been conducted at CSU, primarily by Dr. Abdel Berrada who will be consulted throughout this project. Water use requirements for hemp are difficult to obtain, although CSU Extension summarized data provided by a variety of sources and presented the best known information available[2]. Researchers at CSU contend that hemp typically requires at least 25-30 inches of irrigation during the growing season, slightly more than corn and soybeans.

---

[1] Industrial hemp means a plant of the genus Cannabis and any part of the plant, whether growing or not, containing a delta-9 tetrahydrocannabinol (THC) concentration of no more than three-tenths of one percent (0.3%) on a dry weight basis.

[2] Hammond et al. 2015. Current Impacts of Outdoor Growth of Cannabis in Colorado. CSU Extension Fact Sheet 0.308.

ATTACHMENT A

BUDGET BREAKDOWN

PROJECT TITLE: Quantification of industrial hemp CU rates, THC levels, weed pressure, and disease effects under irrigated conditions in Western Colorado

PERSONNEL SALARIES	**YEAR 1**
Academic Faculty:	$ 0
Fringe:	$ 0
Administrative Professional:	$ 0
Fringe:	$ 0
Post Docs, Interns, GVR:	$ 0
Fringe:	$ 0
Non-Student Hourly:	$ 5,000
Fringe:	$ 1,380
GRA'S:	$ 0
Fringe:	$ 0
TOTAL SALARY:	$ 5,000
TOTAL FRINGE:	$ 1,380
TOTAL PERSONNEL:	**$ 6,380**
DOMESTIC TRAVEL:	**$ 1,000**
MATERIALS AND SUPPLIES:	**$ 30,000**
Metering and moisture sensing equipment (WCRC) – moisture probes, flow meter	$ 12,000
Metering and moisture sensing equipment (SWCRC) – moisture probes, flow meter	$ 12,000
Small-scale lysimeter parts – load cell, tripod, pots	$ 2,000
Irrigation system parts – mulch, tape, couplers, PVC piping, connectors	$ 1,000
Growing system seed, supplies and parts	$ 3,000
OTHER DIRECT COSTS	
Publications:	$ 0
Laboratory Fees (soils):	$ 1,000
Laboratory Fees (plants):	$ 5,000
TOTAL OTHER DIRECT:	**$ 6,000**
TOTAL DIRECT COSTS:	**$ 43,380**
INDIRECT 15%:	**$ 6,507**
TOTAL:	**$ 49,887**

BUDGET JUSTIFICATION

Project Title: Quantification of industrial hemp CU rates, THC levels, weed pressure, and disease effects under irrigated conditions in Western Colorado

Wages for Non-Student Hourly. Additional student or assistant to be hired from Colorado Mesa University or surrounding area.	
TBD-Base Wages $ 12/hr @ 417 Hrs = $5,000	
Fringe Benefits for Non-Student Hourly. Fringe benefit applicable to non-student.	
27.60% Fringe X $5,000 = $1,380	
Domestic Travel.	
Travel from Western Colorado to Denver to present at CWC Annual Meeting 400 miles X $0.48/mile/2WD X 1 trips = $192 700 miles X $0.48/mile/2WD X 1 trips = $336 Hotel Stay = $472 **TOTAL**	**$ 1,000**
Materials and Supplies. $30,000	
Metering and moisture sensing equipment (WCRC) – moisture probes, flow meter	$ 12,000
Metering and moisture sensing equipment (SWCRC) – moisture probes, flow meter	$ 12,000
Small-scale lysimeter parts – load cell, tripod, pots	$ 2,000
Irrigation system parts – mulch, tape, couplers, PVC piping, connectors	$ 1,000
Growing system seed, supplies and parts	$ 3,000
TOTAL	**$ 30,000**
Services or Consultants.	
Publications:	$ 0
Laboratory Fees (Field Capacity, Wilting Point, Texture):	$ 1,000
Laboratory Fees (THC, CBD):	$ 5,000
TOTAL	**$ 6,000**
Indirect (15%) Costs.	
$43,380 X 15% = $6,507	
PROJECT TOTAL	
$49,887	

Department Accounting Contact Information. Cliff Schulenberg, Manager of Grant Facilitation, University Services Center 408F, (970) 491-0926, Cliff.Schulenberg@colostate.edu

Department Head Contact Information: Eugene Kelly, Director, CSU Agricultural Experiment Station, (970) 491-5371, Eugene.Kelly@ColoState.EDU

Perry E. Cabot

Research Scientist
Colorado Water Center, CSU Extension and Colorado Agricultural Experiment Station
Colorado State University
Office: (970) 434-3264 x 203 | perry.cabot@colostate.edu

a. Education

Institution	Degree	Year
University of Wisconsin-Madison	Ph.D., Agricultural Engineering and Land Resources	2006
University of Illinois at Urbana-Champaign	M.S., Environmental Engineering	1999
Colorado State University	B.S., Civil Engineering	1994

b. Academic Positions

- 2016 - Research Scientist/Scholar III, Colorado Water Institute, CSU Extension and CSU Agricultural Experiment Station
- 2014-2016 Research Scientist/Scholar II, Colorado Water Institute, CSU Extension and CSU Agricultural Experiment Station
- 2011-present Research Scientist/Scholar II, Colorado Water Institute, CSU Extension
- 2009 Fulbright Scholar and Lecturer, University of Zambia
- 2008-2011 Regional Specialist, Colorado Water Institute, CSU Extension
- 2006-2007 Post-Doctoral Research Associate. University of Wisconsin-Madison.
- 2000 Research Associate. University of Illinois at Urbana-Champaign.

c. Refereed Publications (2011 – present)

- Gautam, S., P. Cabot and J. Chávez. *In Review*. Multispectral Remote Sensing to Estimate Crop Coefficients and Evapotranspiration Rates of Grass Hay/Pastures in Western Colorado. *Irrigation Science*.
- Lakshminarayanan, A. D.B. Olsen and **P.E. Cabot**. 2014. Engine Performance Testing, Fuels Evaluation, and Enterprise Budgeting for a Simplified Approach to Diesel Biofuel. *Applied Engineering in Agriculture*.
- Drenth, A., D. B. Olsen, **P. E Cabot**, J. J. Johnson. 2014. Compression Ignition Engine Performance and Emission Evaluation of Industrial Oilseed Biofuel Feedstocks Camelina, Carinata, and Pennycress across Three Fuel Pathways. *Fuel*.

d. Non-Refereed Publications (2011 – present)

- **Cabot, P.E.**, B.J. Osborn, J.P. Schneekloth and R.M. Waskom. *Forthcoming*. Water Allotments and Water Shares on Colorado Land. CSU Extension Fact Sheet.
- **Cabot, P.E.**, B.J. Osborn, J.P. Schneekloth and T.K. Gates. *Forthcoming*. Irrigation Water Flow Measurement. CSU Extension Technical Bulletin.
- **Cabot, P.E.**, T.A. Bauder and D.A Dean. *Forthcoming*. Algae Management in Commercial and Residential Ponds. CSU Extension Technical Bulletin.
- Moore, C.D., G. Richard and **P.E. Cabot**. 2016. Floating Wetland Systems Managing Aquatic Plants as a Selenium Sequestration Strategy. Colorado Water. 33(2):10-12.

- Coleman, C., J.R. Poppleton, **P.E. Cabot**, J. Clary, K. Fefes, B. O'Brien, H. Piza and R. Waskom. 2016. Citizen's Guide to Water Conservation. Denver, Colorado: Colorado Foundation for Water Education.
- **Cabot, P.E.**, C.C. Olson, R.M. Waskom and K.G. Rein. Rainwater Collection in Colorado. CSU Extension Fact Sheet 6.707.

e. Research and Extension Presentations (2011 – present)

- Colorado Water Bank Field Research. 2016. Colorado Water Congress. Steamboat Springs, CO. August 24, 2016.
- Compact Water Bank Studies in Western Colorado. Southwest Colorado Research Center Conference. Cortez, CO. February 3, 2016.
- Southwest Agricultural Seminar. "Exploring Innovation and Efficiencies." Cortez, CO. December 4, 2015.
- American Water Resources Association Annual Water Resources Conference. "Agronomic Responses of Grass and Alfalfa Hayfields to No and Partial Season Irrigation as Part of a Potential Colorado Western Slope Water Bank" with Joe Brummer, Lyndsay Jones, Calvin Pearson and Abdel Berrada. Denver, CO. November 19, 2015.
- Upper Colorado River Basin Water Forum. "Update on No Chico Brush Agricultural Irrigation Efficiency Project." Grand Junction, CO. October 28, 2015.
- Upper Colorado River Basin Water Forum. "Update on Colorado Water Bank Project: First Year of Results on Agronomic Impacts and Measurements of Water Savings." Grand Junction, CO. October 29, 2015.
- Technical Challenges in Agricultural (and Food Production) Water Conservation. 2015. Martz Summer Conference. Getches-Wilkinson Center and CU-Boulder School of Law. Boulder, CO. June 11, 2015.
- Growing Agriculture by Applying Science and Technology. 2015. 40th Annual Western Water Workshop. Western State Colorado University. Gunnison, CO. June 24, 2015

i. Current Projects and Funding

- Dekalb/Monsanto. Monsanto Variety Trial. 4/1/2019 – 12/1/2019. $1,800. Current Support.
- Colorado Department of Agriculture. Hemp Variety Tests Program. 05/25/2019 – 10/31/2019. $3,000. Pending Support.
- Colorado Wheat Research Foundation. Promoting Wheat as an Alternative Crop for Reduced Water Use in Western Colorado. 3/1/2019 – 3/1/2022. $7,700. Current Support
- City of Steamboat. Alternative Forage Species for Mountain Meadow Hay Production, Quality and Recovery In The Yampa Basin Under Different Irrigation Regimes. 05/01/2019 – 10/01/2022. $31,128. *Pending Support.*
- Colorado Corn Growers Association. Reduced Tillage and Residue Management to Enhance Soil Health and Provide Economic Incentive for Corn Growers. 04/01/2019 – 01/31/2020. $24,218. Current Support.
- Colorado Water Conservation Board. No Chico Brush Agricultural Water Research Project. 2015-2020. $90,000.
- Colorado Water Conservation Board. A farmer-led initiative to quantify and demonstrate irrigation efficiencies at farm-scales through instrumented water budgeting. 2015-2020. $173,080.