2023 Field Day

USDA-ARS Central Great Plains Research Station

Akron, Colorado

August 16, 2023

USDA Agricultural Research Service

Colorado State University

Contents

Agenda

2023 Field Day
Wednesday, August 16, 2023
USDA-ARS Central Great Plains Research Station
Highway 34, Four Miles East of Akron, Colorado

INDOOR FIELD DAY BUILDING – MACHINERY SHED

8:00 Registration, Coffee, Donuts

8:30 Welcome to our Dryland Agricultural Research Station
Kyle Mankin (Research Leader, WMSRU, Fort Collins)
Peter Kleinman (Research Leader, SMSBRU, Fort Collins)

8:40 2023 Weather Update
Russ Schumacher (State Climatologist, Colorado State University)

9:00 Wheat Stem Sawfly Survey
Adam Osterholzer, Dr. Punya Nachappa (Entomology, Colorado State University)

9:15 2023 Disease Update, Tan Spot in Wheat
Ron Meyer (Extension Agronomist, Colorado State University)

OUTDOOR FIELD TOUR – PEOPLE-MOVER WAGONS

9:30 – 12:00 *Please join one of the two sets of wagons parked outside the machinery shed to tour research sites.*

TOUR 1	**TOUR 2**	**(*** ***Starts Here)***
1*	6	Precision Agriculture and Wheat Yield Maysoon Mikha, Shabaz Khan, Kyle Mankin (USDA-ARS, Akron, CO)
2	7	Rye: Friend or Foe? *and* The Value of Standing Crop Residue Dave Poss (USDA-ARS, Akron, CO)
3	5	Kernza® / Intermediate Wheatgrass Study Grace Miner, Ali Hamm, Dave Poss, Pete Kleinman (USDA-ARS, Fort Collins, CO)
4	4	Break (Snacks & Porta-potties)
5	3	2023 Crops Testing Sorghum Research Activities and Information Sally Jones-Diamond (Colorado State University)
6	2	Irrigation Management of Cowpea & Alternative Crop Rotation Trials Joel Schneekloth (Colorado State University) Jessica Davis (Colorado State University)
7	***1****	Corn Nitrogen x Water Study Louise Comas, Tyler Donovan, Cathy Stewart (USDA-ARS, Fort Collins, CO)

LUNCH – INDOOR FIELD DAY BUILDING

12:00 – 1:00 *Provided by our sponsors!*

ALTERNATIVE CROPS DISCUSSION

1:00 *What is the next big thing for alternative crops in dryland systems?*
We'd like to hear perspectives about what's working, what's not, and where do we go from here.

DISCUSSION LEADERS:
Alan Linnebur, Doug Schmale (Dryland Farmers)

2:00 <u>Done!</u>

Our Staff

Back Row: Cameron Lyon, Cody Hardy, Paul Campbell, Kyle Mankin, Peter Kleinman, Ayden Marler, Sally Jones-Diamond, David Poss
Front Row: Stacey Poland, Carolyn Brandon, Addison Weis, Maysoon Mikha, Shahbaz Khan, Kelbi Schwartz, Molly Porteus, Vashti Winter, Brock Swedlund. [Absent: Joel Schneekloth, Ed Asfeld, Candace Talbert, Emily Williams, Caleb Poss, Susan Pieper]

Scientists

Dr. Kyle Mankin, Research Leader, Agric. Eng.
Dr. Peter Kleinman, Research Leader, Soil Sci.
Dr. Maysoon Mikha, Soil Scientist

Support Scientist

David Poss, Soil Scientist

Technicians

Paul Campbell, Biological Science Tech.
Cody Hardy, Agricultural Sci. Research Tech.
Stacey Poland, Agricultural Sci. Research Tech.
Kelsey Strand, Biological Science Lab Tech.
Tyler Untiedt, Agricultural Sci. Research Tech.

Administrative

Travis Vagher, Administrative Officer
Carolyn Brandon, Secretary Office Automation
Becky Hutchens, Program Support Assistant

Postdoctoral Researchers

Dr. Shabaz Khan, Soil Scientist (CSU)
Dr. Sushant Mehan, Agrohydrology (CSU)

Seasonal Technicians

Ayden Marler (CSU)
Susan Pieper (ARS/CSU)
Molly Porteus (CSU)
Caleb Poss (ARS)
Kelbi Schwartz (ARS)
Brock Swedlund (ARS/CSU)
Emily Williams (ARS/CSU)
Vashti Winter (ARS/CSU)

CSU Staff

Joel Schneekloth
Sally Jones-Diamond
Ed Asfeld
Candace Talbert

Thank You Sponsors!

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CHS-M&M Co-Op Colorado

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Colorado Wheat Administrative Committee

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Stockmens Bank of Colorado Springs

Ward Laboratories

West Plains Company

Y-W Electric Association

Welcome to our Dryland Agricultural Research Station

Dr. Kyle Mankin

Research Leader, Agricultural Engineer
USDA-ARS, Water Management & Systems Research Unit, Fort Collins, CO

Dr. Pete Kleinman

Research Leader, Soil Scientist
USDA-ARS, Soil Management & Sugar Beet Research Unit, Fort Collins, CO

Welcome to our 114th annual Field Day! For over a century, this Research Station in Akron has served the farmers of this region and addressed the issues of dryland agriculture unique to this part of the Great Plains.

The "Akron Sub-Experiment Station" was started in 1907 by the efforts of an interested group of farmers and community members who wanted Akron to be the center of regional dryland agricultural research. The first crop rotation studies were established in 1909, and the classic work of Briggs and Shantz on the water requirements of plants spanned 1910-1920. The Horse Barn still on the station today was constructed in 1914 and remodeled in 1958 as a community meeting place. In 1956, the Akron Field Station was desingated as a regional experiment station for the Central Great Plains and charged to work on the agricultural problems of a 55-million acre area in eastern Colorado, western Kansas, southwestern Nebraska, and southeastern Wyoming. The wheat variety trials were moved south of Highway 34 in 1958 and remain there today. In the same year, Wayne Shawcroft, our trusted agricultural meteorologist, began work at the Station.

We continue to serve the farmers of this region and address the issues of dryland agriculture unique to this part of the Great Plains. We are excited to be interviewing for a research agronomist with expertise in nutrient management, our first new scientist in almost 20 years! We are renovating the office building, originally built in 1976. In Fall, we will start a monthly seminar series on topics of interest to dryland farmers. We are expanding both our on-station and on-farm research to make sure our research remains connected to real dryland agricultural production systems.

Enjoy the Field Day! Let us know if you have ideas to keep this research station focused on the most important dryland agricultural issues.

Kyle Mankin

kyle.mankin@usda.gov

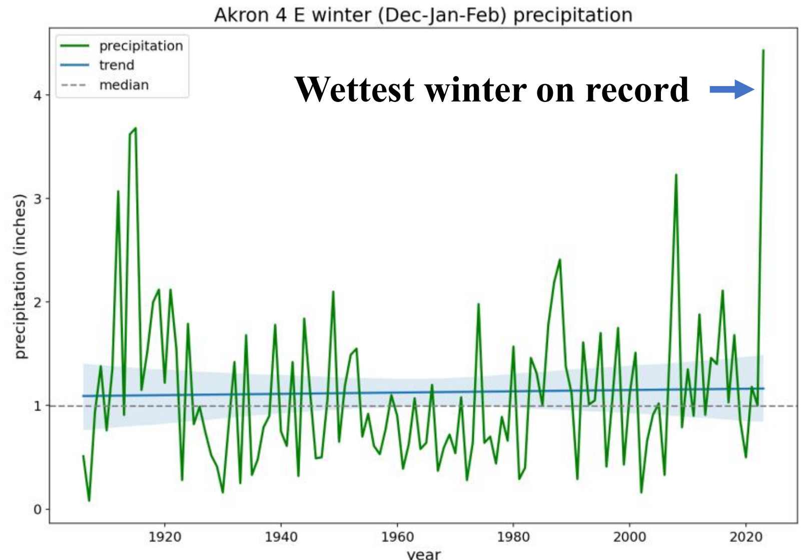
Pete Kleinman

peter.kleinman@usda.gov

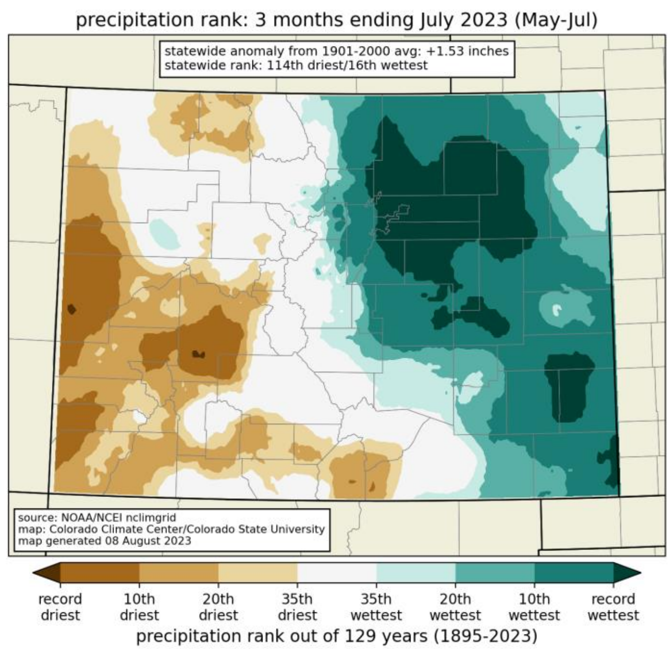
2023 Weather Summary:
A Year of Extremes in Washington County

Dr. Russ Schumacher

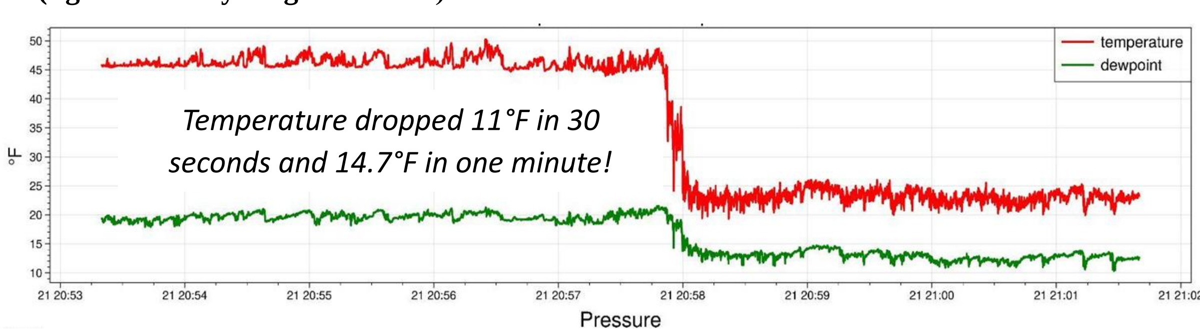
State Climatologist, Colorado State University



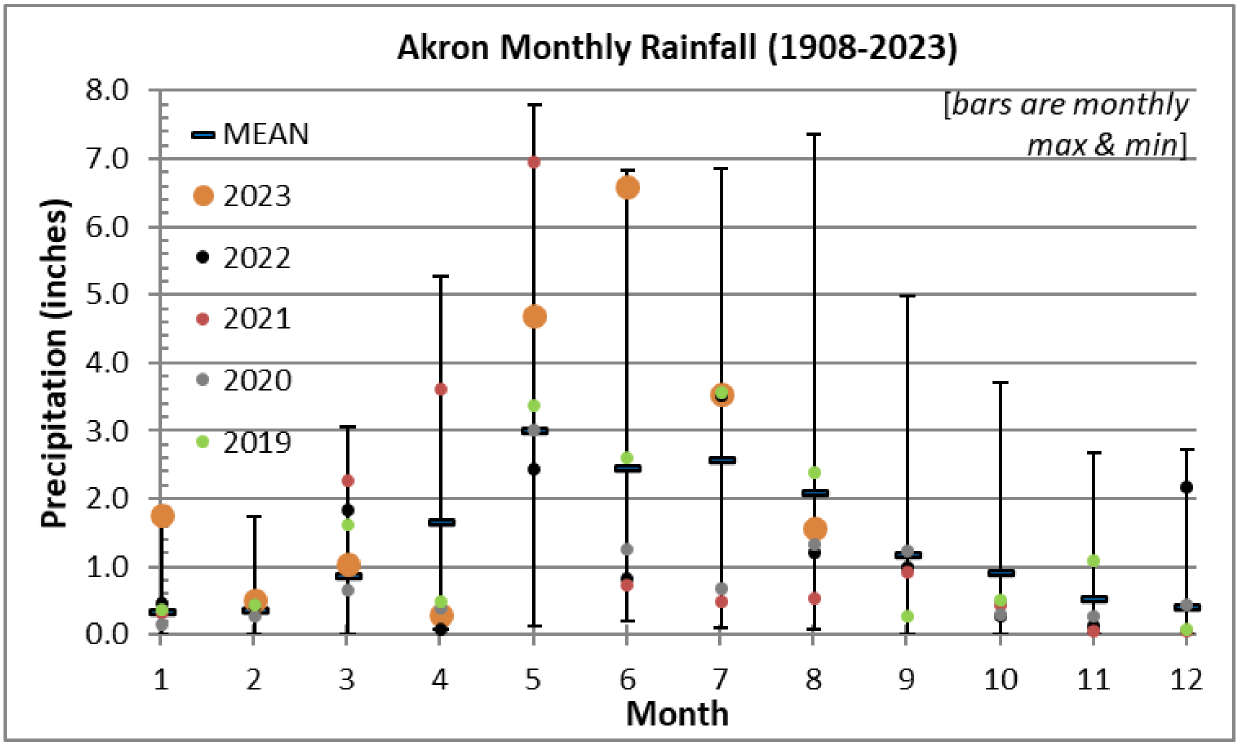
Tons of spring and summer rain



December 21, 2022 cold front
(figure courtesy Megan Franke)



34 tornadoes on June 21!
(Photo by Tony Laubach via NWS Boulder)



(figure courtesy Dave Poss, Kyle Mankin)

Wheat Stem Sawfly Survey (In Progress)

Adam Osterholzer
Research Associate, Colorado State University

Dr. Punya Nachappa
Associate Department Head, Colorado State University

The CSU Wheat Entomology Program is currently conducting its annual Wheat Stem Sawfly (WSS) survey in wheat-producing counties in Eastern Colorado. At each survey location, we determine the average infestation within 100 wheat stems. This data is then used to create an infestation map showing sawfly pressure across the state (see **Figure 1** for our 2022 data).

This year, we will also record infestation and field data for ~15 sites in CO where we have access to extensive crop rotation histories. We will then try to determine how different crop rotations impact sawfly infestation. Additionally, we will visit several locations in Kansas to track any sawfly movement across the border.

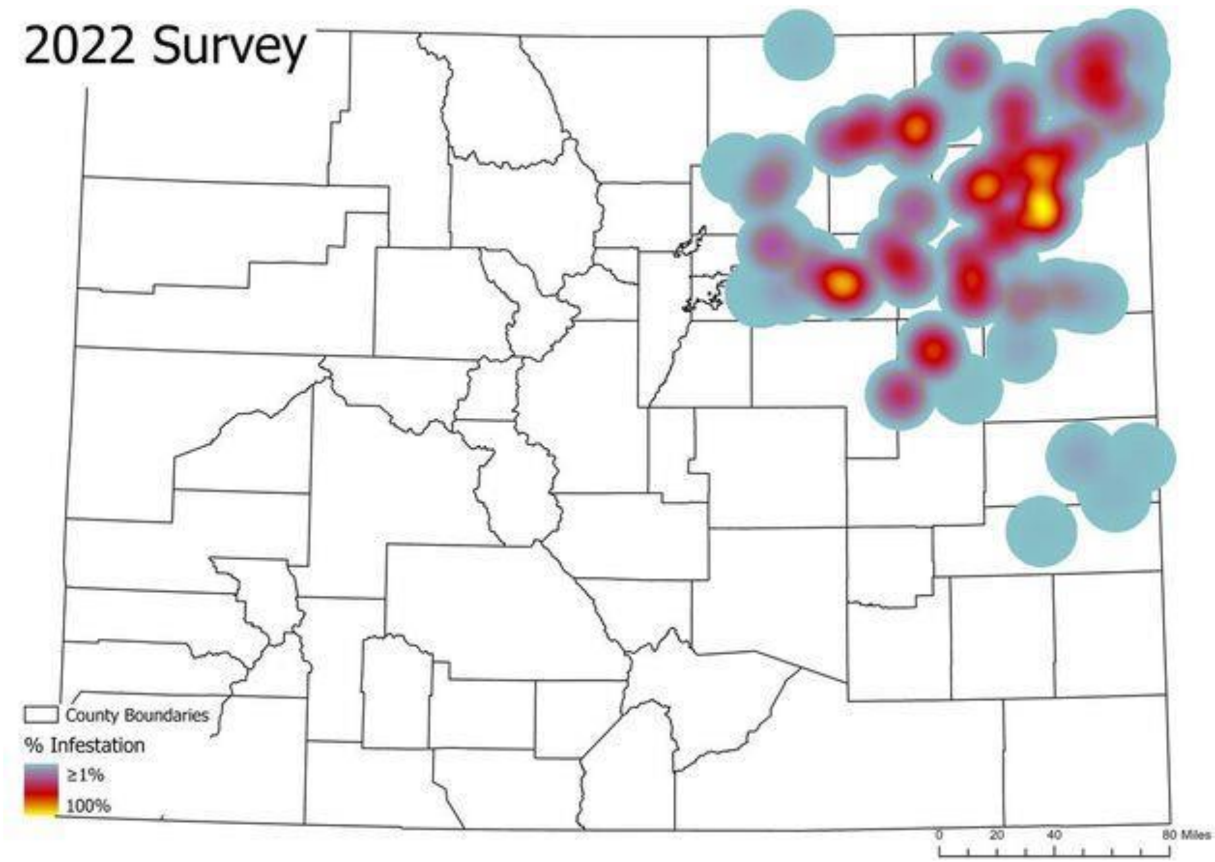


Figure 1: Map of 2022 WSS Infestation in Colorado.

Due to the delayed 2023 wheat harvest, we expect to finish our current survey in September. Results will be made available via the Colorado Wheat newsletters and our website at www.csuwheatentomology.com. See **Figure 2** for our most recent data, updated 8/7/2023.

County	# Of Sites Visited	Avg. WSS Infestation Per Site
Adams	7	20.7%
Arapahoe	2	4%
Boulder	1	25%
Lincoln	3	26%
Larimer	1	3%
Phillips	1	4%
Washington	3	25.7%
Yuma	3	24.7%
Weld	4	25.25%
Morgan	2	10%
Logan	3	48.6%

Figure 2: Summary of WSS 2023 Survey Data, Updated 8/7/2023

Our study of this year's WSS emergence cycle at Orchard and New Raymer, CO has been finalized (see **Figure 3**). The average number of sawflies in 2023 was 18 per survey site, which was significantly lower than many previous years. In addition, the sawflies appeared to be delayed in emergence and peaked at the end of May. We noticed higher populations of sawflies in areas that received less moisture compared to New Raymer/Orchard.

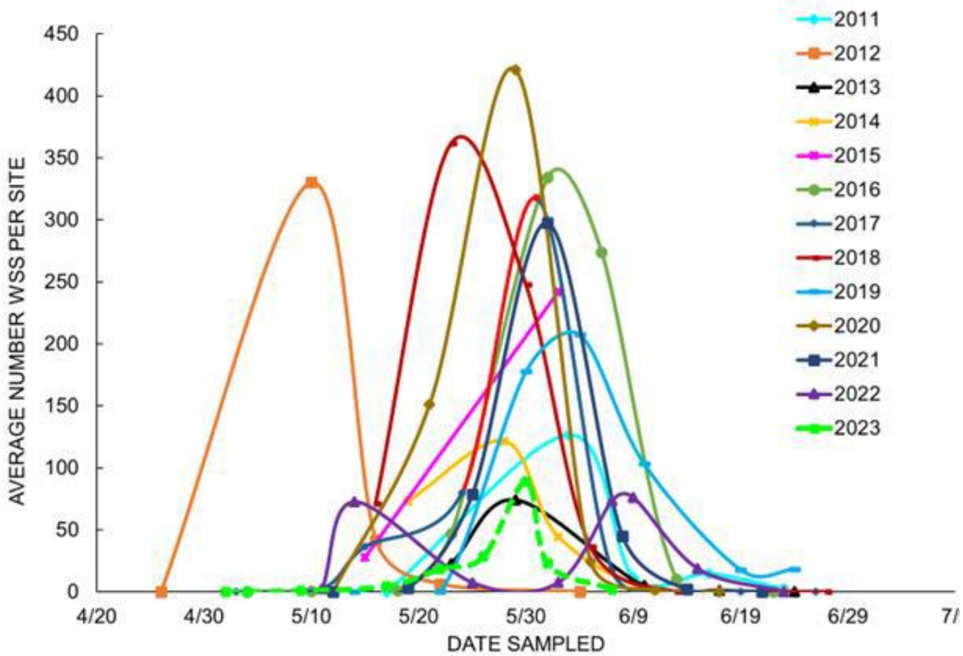


Figure 3: Graph showing historical WSS flight data in Orchard and New Raymer, CO. The dashed green line is our 2023 data.

2023 Disease Update, Tan Spot in Wheat

Ron Meyer

Extension Agronomist, Colorado State University

Tan spot is caused by a fungal pathogen, *Pyrenophora tritici repentis*, which survives on the previous year's wheat stubble. The disease can lead to poor tillering and continued development can reduce yield. Tan spot is typically noticed in the lower canopy in early spring. The disease rarely survives Colorado's warm dry environment later in the growing season. However, the 2023 growing season experienced wetter and cooler than normal conditions. As a result, tan spot continued to flourish and in some fields, advanced to the flag leaf. This necessitated a fungicide application in some fields this season. The strategy with many fungal diseases is to protect the flag leaf during the growing season. As a result of the wet conditions, this was the first time fungicides were advised to control tan spot in wheat in 30 years.

Source: Connie Strunk, SDSU Extension Plant Pathology Field Specialist

Precision Agriculture and Wheat Yield

Dr. Maysoon Mikha, Dr. Shabaz Khan, Dr. Kyle Mankin
Soil Microbiologist, Postdoctoral Research, Agricultural Engineer
USDA-ARS, Akron, CO

Introduction

Increase in the world's population and demand for food & fiber challenge the agricultural industry to increase food production. *Precision agriculture is a management strategy that could increase land productivity, reduce inputs, and enhance economical return* while confronting challenges of a shifting climate.

Objective

Compare the effects of a less-intensive "business-as-usual" (BAU) and more-intensive "aspirational" (ASP) management systems on crop productivity.

Material & Methods

The study was initiated in 2018 in Akron, Colorado on field-size plots range from 6-11 ac. The plot management consists of: (i) BAU cropping practice, typical of the region, with reduce tillage (RT) and a two-year rotation of wheat-fallow (WF-RT), and (ii) ASP cropping practice using no-tillage (NT) and a four-year rotation of winter wheat-corn-millet-flex (WCM-flex). Each phase of each rotation was included in each year of the study (2018-2022) with three replications. In each ASP field, three yield-management zones were defined as high, medium, or low based on prior yields (**Figure 1**).

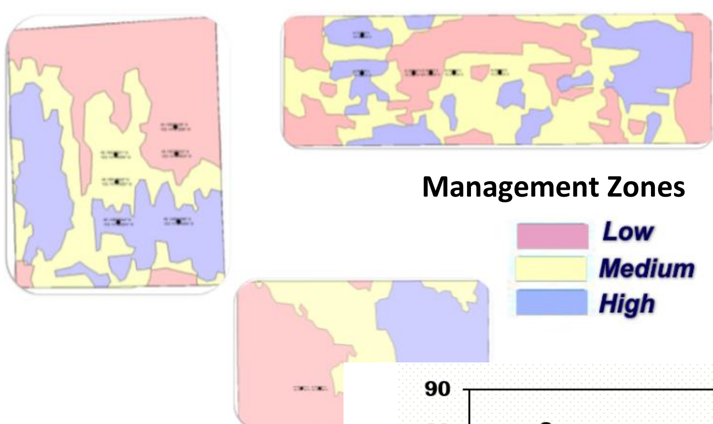


Figure 1. Field organized into three management zones for different nutrient managements & crop yield evaluation. The black dots represent the neutron probe for soil moisture evaluation.

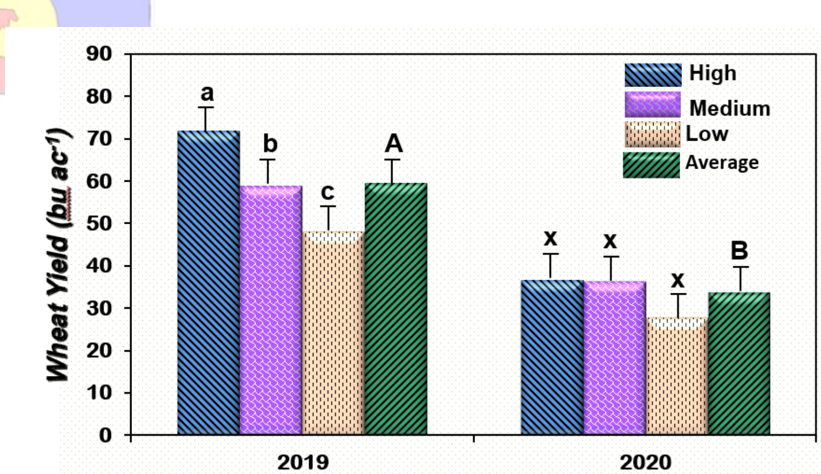


Figure 2. Wheat yield (bu/ac) associated with the aspirational (ASP) management for 2019 & 2020 growing seasons.

Results & Discussions

In 2019, yield-management zones showed significant effect on wheat yield. The yield associated with high yield-management zone was significantly higher than the medium zone follow by the low zone. However, in 2020 no significant differences in wheat yield was observed among the yield-management zones. Across the field the 2019 wheat yield was significantly higher than in 2020.

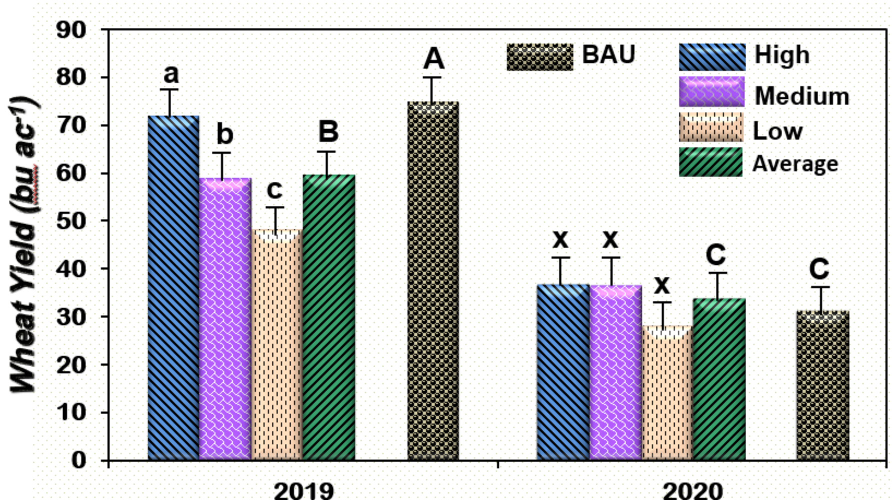


Figure 3. Wheat yield (bu/ac) associated with the Business-As-Usual (BAU) & aspirational (ASP) management systems for 2019 & 2020 growing seasons. ASP fields were divided into three yield-management zones (high, medium, or low) based on prior yields.

In 2019, wheat yield was about 75 bu ac^{-1}, with BAU was not significantly different than ASP-high yielding zone, 72 bu ac^{-1}. The ASP-medium (21%) and ASP-low (35.7%) yielding zones exhibited significantly less yield than the BAU. In 2020, wheat yield was 37 bu ac^{-1} at high and medium zones which was about 17% higher than BAU, 31 bu ac^{-1}.

The wheat yield in 2019 with BAU management was significantly higher by 20% (75 bu ac^{-1}) than the ASP wheat yield averaged across the three zones (60 bu ac^{-1}). However, in 2020 the BAU wheat yield was about 8% lower that the ASP yield average across the three zones, but it was not significant.

The reduction in yield in 2020 was due to increase the annual temperature (50.5°F compared to 110-year mean of 48.9°F) and low annual precipitation (9.7 inches compared to 115-year mean of 16.5 inches).

Conclusions

Our results suggested that under favorable environment, no differences in wheat yield was observed between BAU and ASP-high yielding zone. As the environment turn to unfavorable, the ASP exhibit higher yield than BAU. Indicating that the ASP has a potential to improve yield and mitigate climate change challenges in dryland cropping system.

This project could provide a unique opportunity to evaluate precision farming practices for the dryland cropping system in the Central Great Plains Region.

Acknowledgment

We would like to acknowledge the Akron research location employees (Cody Hardy, Carolyn Brandon, David Poss, Paul Campbell, and Stacey Poland) and term employees (Cameron Lyon and Susan Pieper) for their hard work and dedication to Akron research projects.

Rye: Friend or Foe?

David J. Poss
USDA-ARS, Akron, CO

Problem: Rye in dryland cropping systems is thought of a weed more than a crop. Volunteer (feral) rye has been present as a weed in our winter wheat crop for nearly a century. Some areas it has persisted worse than others. Due to recent breeding efforts, the seed from the newer varieties persists only for a short time in the soil, like winter wheat. The germination rate of the seed left in the field after harvest is very high, allowing a producer to terminate those rye plants before planting the next winter annual crop such as wheat or rye two to three years later. Through hybridization of rye, grain yields have exceptional potential. So, if the volunteer issue has been overcome then rye may be a good fit in copping systems in the Plains area.

Approach: In summer 2021 it was decided to establish a study to evaluate the claim that hybrid rye does not volunteer any more than wheat. This study includes three rotations, two which are common in the area including Wheat-Corn-Millet-Fallow and Wheat-Corn-Fallow. During the 'wheat' phase the plots were split in half with half the plot being planted to wheat and other half being planted to rye. Then when that plot is in the 'wheat' phase again, wheat will be planted where rye was originally planted, and rye planted where wheat was originally planted. We will then observe and measure the number of volunteer rye plants in the wheat and the percent rye seed in the harvested wheat grain.

Results: Since this study was established two years ago, and the shortest rotation is three years we do not have numerical data to demonstrate that the hybrid rye volunteer issue is not a problem yet. However, we have grown rye in variety trials since the 2016-17 crop year. These fields were in a four-year rotation, and we have not seen any volunteer rye in the subsequent crops, including wheat four years later. The potential of hybrid rye is tremendous. The grain yield of the rye in our variety trials as surpassed 100 bu/ac on multiple occasions. In side-by-side comparisons in the Volunteer Rye the yield from rye has been approximately 50% greater than wheat. This year, in plots following fallow the average rye yield was 107.4 bu/ac compared to 70.0 bu/ac for wheat. A yield of 70 bu/ac in wheat is an outstanding yield for this region.

Wheat and Rye grain yields in Volunteer Rye Study at Akron in 2023.

Rotation	2022 Crop	Wheat	Rye
		bu/ac	bu/ac
Wheat-Rye	Rye or Wheat	57.9	97.5
W(R)-C-F	Fallow	64.8	104.6
W(R)-C-M-F	Fallow	75.1	110.2
Mean		65.9	104.1
Mean following fallow		70.0	107.4

Seeding costs and gross revenue comparison for 2022-23 crop year.

	Wheat	Rye
Seed costs		
Seeding rate	60 lb/bu	650K/ac
Seed price	$18/bu	$68/Mil seeds
Seed Cost	**$18/ac**	**$44/ac**
Revenue		
Yield	70 bu/ac	107 bu/ac
Price	$6.75/bu	$5.75/bu
Total Revenue	**$475/ac**	**$615/ac**

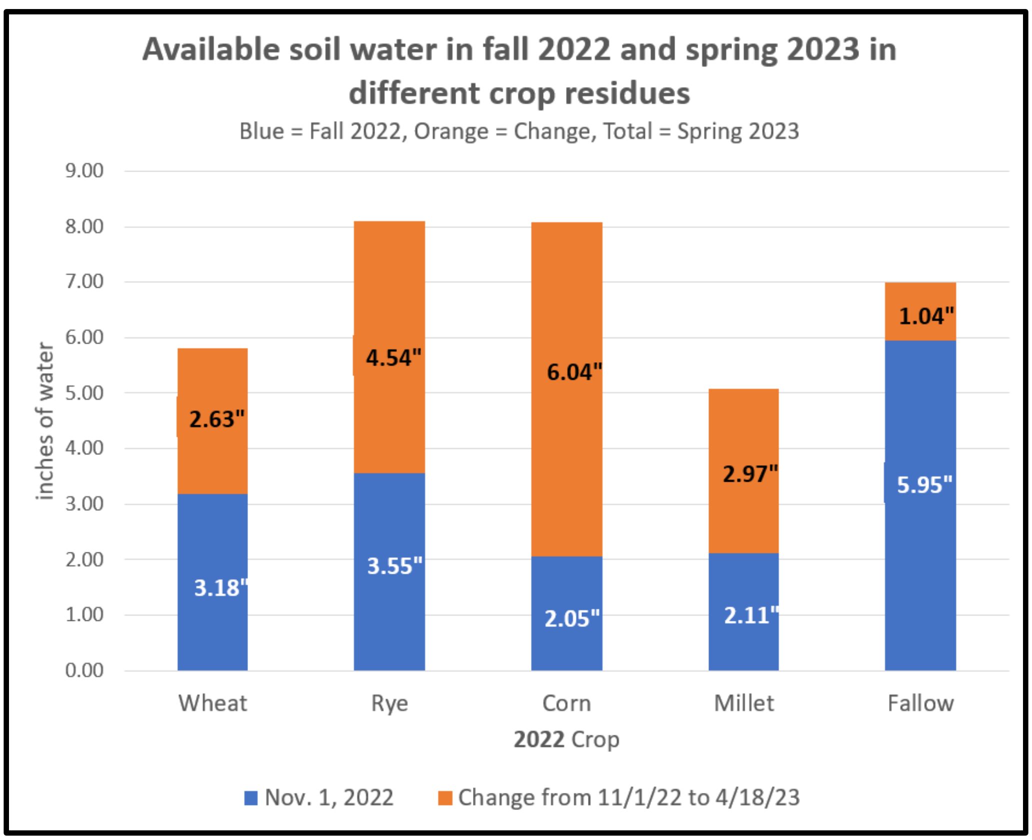
The Value of Standing Crop Residue

David J. Poss

USDA-ARS, Akron, CO

Approach: In fall 2022 neutron access tubes were installed in all the plots in the Volunteer Rye Study. The purpose was to measure the soil water throughout the growing season to quantify the effect differing soil water had on crop yield following different residue levels, specifically wheat and rye. Soil moisture was measured in all plots November 1, 2022, to obtain an initial reading. Soil water was measured again April 18, 2023. Snowfall during the 2022-23 winter was exceptional. We measured 58.1 inches of snowfall and 5.72 inches of precipitation from November 1, 2022 through April 18, 2023. Averages for this period are 36.8 inches of snowfall and 3.34 inches of precipitation. Based on our records snow accumulations like last winter occurs approximately every ten years on average. How effectively were the various crop residues able to capture the snow during last winter, especially since there was significant drifting from some of the snowfall event?

Results: There were dramatic differences in the amount of soil water stored during the 2022-23 winter season. Plots which were fallowed in 2022 and planted to wheat in fall 2023 stored the least amount, only 1.04 inches. Contrast this to corn stalks which stored over six inches. The plots which were fallowed in 2022 had no standing crop residue to catch the blowing snow. Also, these plots started out with a higher soil water content, resulting in lower infiltration rate. An interesting comparison is the amount of stored soil water in the wheat stubble vs. the rye stubble. The amount of stored soil water in the wheat stubble was 2.63 inches compared to 4.54 inches in the rye stubble. The primary difference was the rye stubble was standing, whereas the wheat stubble was mostly lodged due to significant wheat stem sawfly damage in 2022.



Hybrid Rye vs. Feral (Volunteer) Rye

Paul Gregor

KWS Cereals, USA Hybrid Rye Product Manager

** Disclaimer: This article is for general information purposes only. The content in this article is not intended to constitute a specific recommendation, assumption, or advice.*

Volunteer or Feral Rye

Feral rye, also known as volunteer rye, is a significantly established weed of dry land cropping. To growers, feral rye is cereal rye gone wild and is a problem in many areas of the United States. Cereal rye is not native to North America and has evolved directly from cultivated cereal rye since its time of introduction in the early to mid1900's. Cereal rye has been used in wildlife and soil conservation seed mixtures, cover crops and pastures, and production agriculture. When cereal rye when feral rye it reduced yield, increased dockage, and reduces quality. Millers, bakers, and distillers avoid buying contaminated grain with feral rye because the flour or alcohol has unwanted characteristics.

Populations of feral rye are weedy in nature due to a common ancestry. Genetic diversity in feral rye is high due to backcrossing from related cultivars and repeated gene flow of feral populations, which was aided by long migrations via water, combines and trucks.

Feral rye is like cereal rye but has the characteristic to shattering easily. Feral rye also flowers later, tillers more, is generally shorter, and produces smaller seeds. It is a winter annual and has ability to persist and lay dormant in the soil for several years. It is very similar to cereal rye in that it is very competitive, has an expansive root system, it manages abiotic stressors, and has allelopathic properties.

Preventative methods are a critical part of controlling volunteer rye:

1. Plant uncontaminated seed, check your lots and seed tags for weed seed.
2. Use tillage, when possible, to destroy any germinating feral rye before it produces seed. Plowing 6" deep could control as much as 90% of the feral rye the following season but, the longevity will increase as depth increases. Prevent bringing this seed back to the surface by reducing plowing intervals.
3. Clean / blow down combines before moving between fields.
4. Cover or tarp trucks during transport, this will help keep rye out of roadside ditches and other areas that may contaminate the fields.
5. Use rotational crops like corn, soybeans, grain sorghum, sunflower, canola, proso millet.
6. Use herbicide in the fall before planting or in spring planted crops or fallow. Use herbicide in the fall before planting or in spring planted crops or fallow.
7. A delay in fall seeding timing can help eradicate more volunteer feral rye when using herbicides or tillage.

Hybrid Rye vs Feral Rye

Hybrid Rye can help reduce the feral rye syndrome through "Hybrid Vigor":

1. Hybrid seed production produces a distinct, uniform, and stable pure line to ensure the grower is getting the same product and results every year when he buys KWS Hybrid Rye varieties.
2. The selection in breeding to reduce dormancy in Hybrid Rye seed helps it to germinate after harvest and be much less likely to go dormant like feral rye.
3. Hybrid Rye is not like the other open pollinated cereal rye's that have been grown multiple years from the original certified seed stock. This continual planting creates variants of the original

variety that can produce genotypes with negative characteristics, possible seed dormancy or weediness.

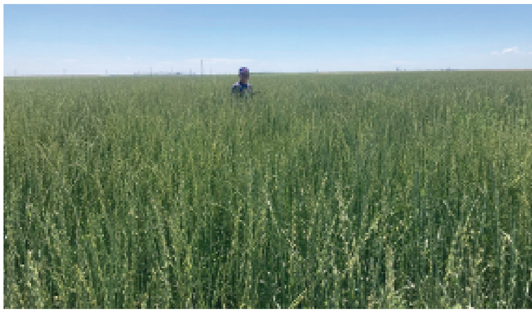
4. Hybrid Rye doesn’t easily shatter like feral rye leaving and extra seed load in the field.
5. Superior standability over other cereal rye for greater combing efficiency and less chance of leaving substantial grain in the field.

Cultural Practices

- Make sure chaff is spread uniformly across the field. Set your straw chopper, or after harvest use a harrow or vertical tillage to distribute the straw uniformly. This way the grain that exits the combine will make its way to the soil surface and germinate with moisture. When most have germinated, you can choose to terminate it or leave it as cover crop and terminate next spring before new crop.
- Avoid deep tillage right after combining. Wait for the potential volunteers from Hybrid Rye to germinate to reduce the risk of volunteers emerging next year.

Kernza® / Intermediate Wheatgrass Study

Dr. Grace Miner, Dr. Allison Hamm, David Poss, Dr. Peter Kleinman
USDA-ARS, Akron, CO



Kernza® / Intermediate Wheatgrass Study

Pete Kleinman, Grace Miner, Ali Hamm, Dave Poss, Catherine Stewart, Kyle Mankin, Justin Derner, and Joel Schneekloth

ABOUT THE CROP

Kernza® is a newly developed intermediate wheatgrass variety being bred toward grain production. Kernza® 's perennial nature offers the potential to minimize farm inputs and field disturbance associated with annual cropping. Its deep perennial roots hold the promise of more fully utilizing using available nutrient and water resources while conserving and building healthy soils. Kernza® is a "dual use" or "flex" crop, with the potential to provide grain and/or forage. Its emerging market is as a high value specialty grain (brewing, distilling, cereals, baking, and more). The cultivation of intermediate wheatgrass for grain, livestock forage, and conservation plantings offers the potential to create new income streams for farmers, diversify cropping systems, and support healthy ecosystems.

COORDINATED NATIONAL RESEARCH

Strategic system-level research is needed to evaluate Kernza®'s potential for transforming farming and regional food systems. Multiple USDA-ARS locations (**Fig 1**) are participating in coordinated field trials to support regional and national conclusions around this novel crop. These trials include two common varieties planted in three consecutive years (staggered starts) in order to understand how conditions at establishment and stand longevity impact grain and forage yields and nutritional quality. All trials include a minimum common core set of soil and plant analyses intended to offer insight into grain and forage yields and nutritive quality, nutrient management needs, water requirements, and potential for increasing carbon sequestration and building soil health.

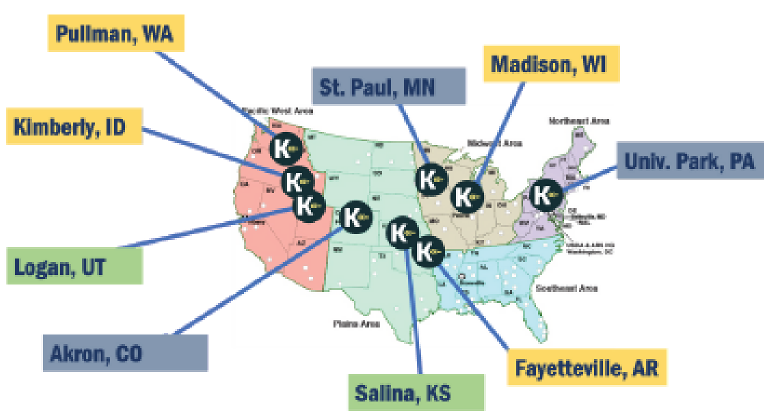


Fig 1. National USDA-ARS locations. This work will inform regionally-specific production of Kernza® and determine what is needed to integrate a perennial grain into systems historically built around annual grains.

AKRON FOCUSED QUESTIONS

At Akron we are focused on understanding if inclusion of perennials like Kernza® with dual use flexibility can support dryland systems operating at the extremes of precipitation and temperature. The experimental design includes four Kernza® varieties, with a split plot overlay where plots are harvested for grain only, or for dual use (grain and forage). A wheat-fallow comparison is also included (**Fig 2).**

KEY MEASUREMENTS

WATER USE AND DROUGHT TOLERANCE

Neutron probes are installed in each plot, with full profile water measured at five key points across the season. These measurements will enable us to track seasonal crop water use and patterns of water extraction, changes in water use with stand longevity, and the ability of perennials to withstand drought stress.

SOIL NUTRIENT DYNAMICS AND SOIL HEALTH

Plots were sampled down to 6 feet at planting and will be sampled each fall for basic fertility and at stand termination for changes in soil carbon. These measurements will give insight into perennial nutrient use and nutrient dynamics and the potential for perennial crops to improve soil health.

GRAIN AND FORAGE YIELDS & QUALITY

Grain and forage yields, nutritive values, and grain end use qualities for brewing and baking will be measured over the life of the stands. These data will be coupled with data on soil fertility, soil water, and growing conditions to rapidly expand the knowledge base for production and end use values.

WHEAT STEM SAWFLY

Wheat stem sawfly has emerged as a significant pest of winter wheat, and can also infest other hollow-stemmed grasses like intermediate wheat grass. Stems from Kernza® and wheat plots were sampled at harvest and will be split to determine the presence and activity of wheat stem sawfly. We are also investigating whether Kernza® can serve as a refuge for parasitoids that would help control stem sawfly populations.

EXPERIMENTAL DESIGN

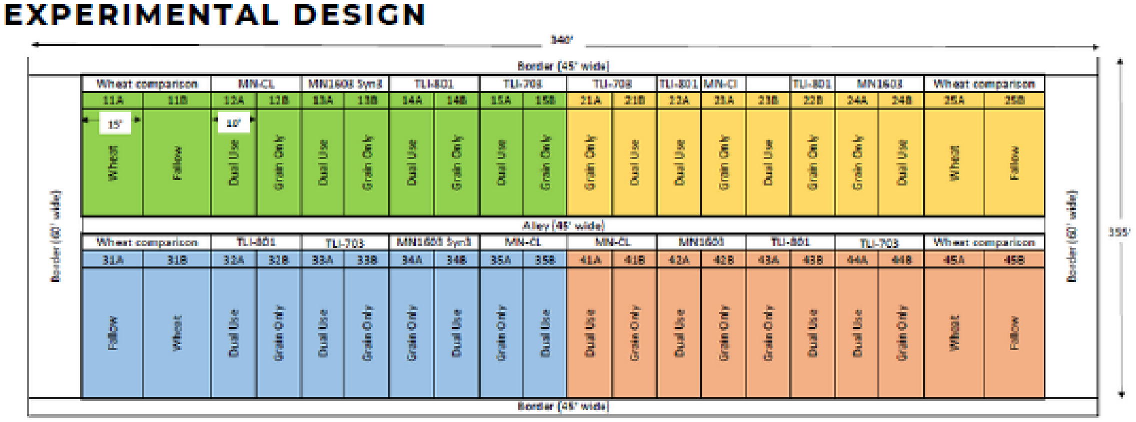


Fig 2. Plot map of Year 1 Kernza® planting, with Wheat-Fallow comparison plots.

2023 Crops Testing Research Activities and Information

Sally Jones Diamond

Director, Crops Testing Program, Colorado State University

Sally will provide an updated wheat report and discuss corn and sorghum trial results.

For details, see the CSU Crop Testing Program website (https://csucrops.com/).

Alternative Crop Rotation Trials

Dr. Jessica Davis

Colorado State University

Jessica will provide an update on alternative crop rotation trial results.

Irrigation Management of Cowpea for NE Colorado

Joel Schneekloth, Sally Jones-Diamond, Maria Munoz-Amatriain

Colorado State University

Cowpea are a relatively new dry bean crop for NE Colorado. Cowpea is well known for its adaptation to drought, heat and poor soils. Discussion with a consultant has expressed concern that the irrigated response of cowpea is not similar to typical dry beans grown in NE Colorado. The thought was that cowpea may have a negative response to typical full irrigation management practices for dry beans such as pintos and kidney beans grown here.

In 2021 and 2022, a study was conducted utilizing a rainout shelter at Central Great Plains Research Station near Akron, CO. Use of the rainout shelter ensures that excessive precipitation events do not interfere with the potential water response and timing of water needs. The rainout shelter is connected to a tipping bucket precipitation gauge that will shut the shelter when precipitation is recorded and open after the precipitation event is over.

Four strategies were looked at within this study: Dryland, 4 inches of irrigation, 8 inches of irrigation and full irrigation practices. All plots received average weekly precipitation amounts weekly via a drip system on the plots. The 4-inch and 8-inch irrigation treatments were targeted towards the reproductive growth stages of cowpea with 2 inches of water applied per week either on a bi-weekly basis or weekly basis. The final treatment was full irrigation management which targeted maintaining plant available soil moisture between 50 and 80% during the growing season.

Results:

Irrigation did increase yield compared to dryland to a point (**Table 1**). Increasing irrigation past the 8 inches allocation did not increase yields or an evapotranspiration (ET) of 15 inches both years. On average, yields increased from 1,185 to 2,469 lb/ac from dryland to 8 inches of applied irrigation. Additional irrigation beyond 8 inches did not increase yield but did increase ET. Most crops generally have a yield response of increasing yield as ET increases. Yields increased by 190 lbs per inch of ET.

Increases in biomass increased with ET. Even though yields did maximize at a lower ET, biomass increased with more ET. Biomass increased at 391 lbs per inch of ET across all water applications. Since yield maximized at 8 inches of irrigation or approximately 15 inches of ET, additional water was only utilized for additional plant biomass growth.

One of the factors to look at is how irrigation impacted yield components such as pods per plant, seed/pod and seed size. Irrigation did not significantly increase seeds per pod. The number of seeds per pod ranged from about 5 to 5.9 for dryland and irrigated respectively.

The two major impacts due to irrigation was pods per plant as well as seed size or seeds per lb. Irrigation at 4 inches seasonally did not increase pods per plant but did significantly increase seed size compared to dryland. The number of seeds per lb was reduced by approximately 20%. Approximately the same number of seeds were produced per acre but it required fewer seeds to produce one pound of yield.

As irrigation increased to 8 inches from 4 inches or dryland, pods per plant increased to generate the increased yield per acre. Adding additional irrigation did not increase pods per plant, seeds per pod or seed size compared to the 8-inch allocation.

Harvest index is the amount of seed produced compared to the total plant biomass production on a dry basis. This is an indication of the efficiency of the plant to produce seed as compared to total biomass. As with yield, the harvest index increased with irrigation up to the 8-inch allocation. Additional irrigation above 8 inches did increase biomass production but did not increase seed production resulting in a slightly lower harvest index. Increased biomass production typically results in greater crop water use or ET. The measured increase in ET for full irrigation compared to the 8-inch allocation was approximately 2.5 inches of water use. This shows the potential savings in irrigation for cowpea with limited irrigation.

Overall, dryland cowpea did produce 1,185 lbs per acre. This has the potential to either replace fallow or become another crop within the rotation for dryland producers. For irrigated producers, the potential of this crop for water savings with either limited water supplies or low capacity wells could prove beneficial in a cropping systems to spread limited water. Overall, 15 inches of ET maximized yield of cowpea. An estimate of ET for a dry bean crop such as pinto is 19.5 inches according to CoAgMet calculations. This is an approximate 4 inches savings of water overall in the system.

Conclusion:

Cowpea appear to be a viable alternative crop for dryland and limited irrigation. Economics appear favorable in a dryland or limited irrigation cropping practice. Cowpea did show that it appears to not increase yield with additional ET. Addition of a broadleaf crop into the system can increase the herbicide options available for weed control. Harvest is early enough to also integrate wheat within the cropping system.

Table 1. Yield components, yield, and ET of cowpea under 4 irrigation management strategies.

Water Treatment	Pods/Plant	Seed/Pod	Seed Size (seed/lb)	Yield (lbs/ac)	Harvest Index (yield/biomass)	ET (inches)
			2021			
Dryland	4.0	4.9	2,185	1,028	0.36	7.8
4 Inches	4.3	5.9	1,753	1,594	0.42	10.5
8 Inches	7.3	5.5	1,941	2,663	0.46	14.5
Full	6.8	5.9	1,935	2,572	0.41	17.8
			2022			
Dryland	4.2	4.7	2,076	1,341	0.39	8.7
4 Inches	5.7	4.5	1,708	2,012	0.33	12.3
8 Inches	5.2	6.0	1,895	2,275	0.36	15.6
Full	7.5	5.1	1,910	2,395	0.37	17.4
			Average			
Dryland	4.1	4.8	2,131	1,185	0.37	8.3
4 Inches	5.0	5.2	1,731	1,803	0.38	11.4
8 Inches	6.2	5.7	1,918	2,469	0.41	15.0
Full	7.1	5.5	1,923	2,484	0.39	17.6

Improving Nitrogen Use in Cropping Systems of Semi-arid Regions

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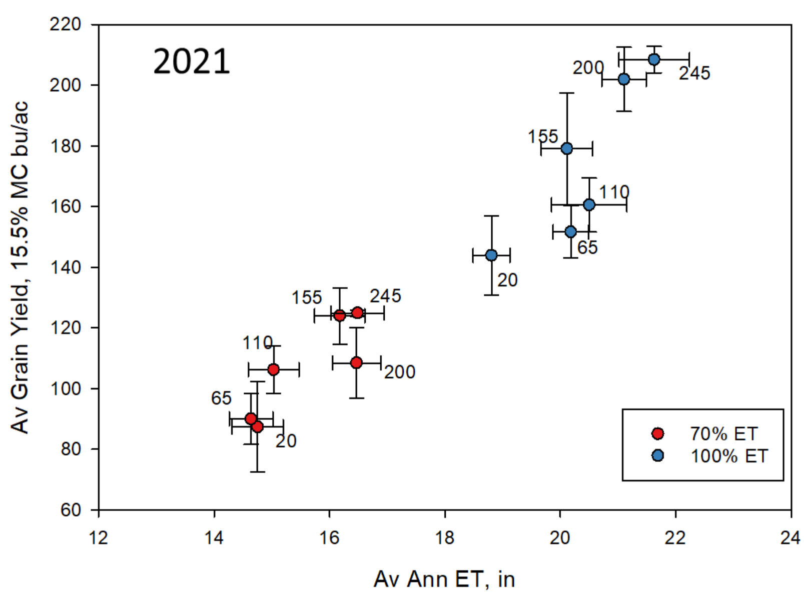
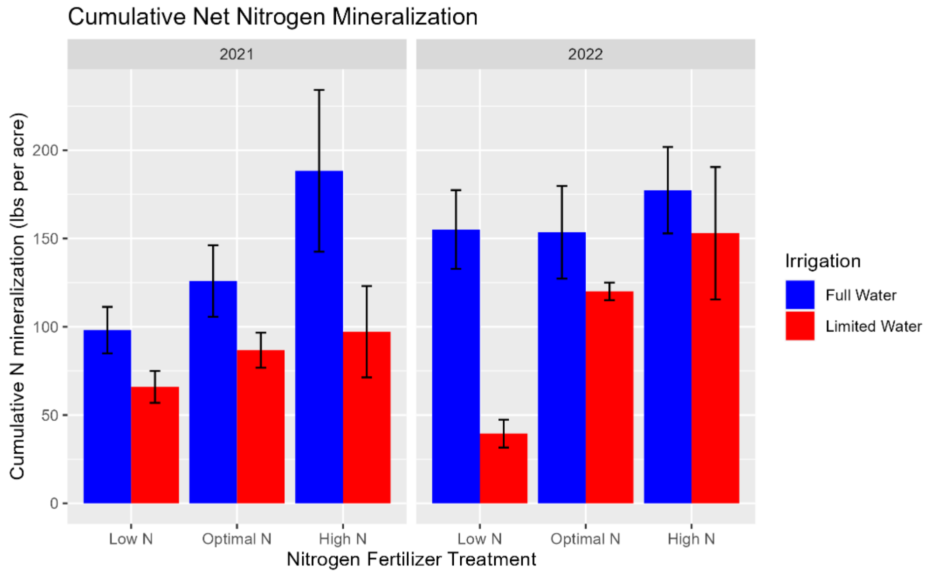
Plant nitrogen requirements are particularly uncertain when water is limited because of the interactive effects of water and nitrogen on plant growth, nitrogen demand, and plant uptake. Determining the ideal reduction in nitrogen fertilization when crops have limited water is not straightforward because studies have suggested that additional nitrogen during water stress allows crops to better handle stress. In addition, recent studies also show that corn gets less than 50% of its nitrogen from the fertilizer applied, underscoring the importance of understanding nitrogen processes in soil for crop management and their contribution to crop nitrogen availability. We explored corn nitrogen requirements in a field experiment with full and near-dryland water availability and six levels of nitrogen from 20-245 lbs/ac. Data suggest that additional nitrogen fertilizer does not increase plant stress tolerance. There is a linear relationship between water used by the cropping system (annual evapotranspiration, ET) and grain yield of corn that was fully watered and near dryland under different nitrogen rates (rates in lbs/ac next to points):



A straight line in this relationship suggests that water use and nitrogen requirements increased proportionally to plant size, but once plants have enough nitrogen to reach their maximum size for the water available, additional nitrogen has no benefit. Under near-dryland conditions, additional nitrogen fertilizer stays behind as increased soil residual nitrogen, which is at risk for leaching.

Water and nitrogen availability can have both direct and indirect and positive and negative effects on nitrogen mineralization rates. Given that soil nitrogen mineralization is such an important source of nitrogen for crops, we explored how nitrogen and water affect net nitrogen mineralization. Measurements were taken during the 2021 and 2022 growing season. 2022 had more rainfall, especially later in the season, and had more extractable nitrogen in the soil compared to the 2021 season.

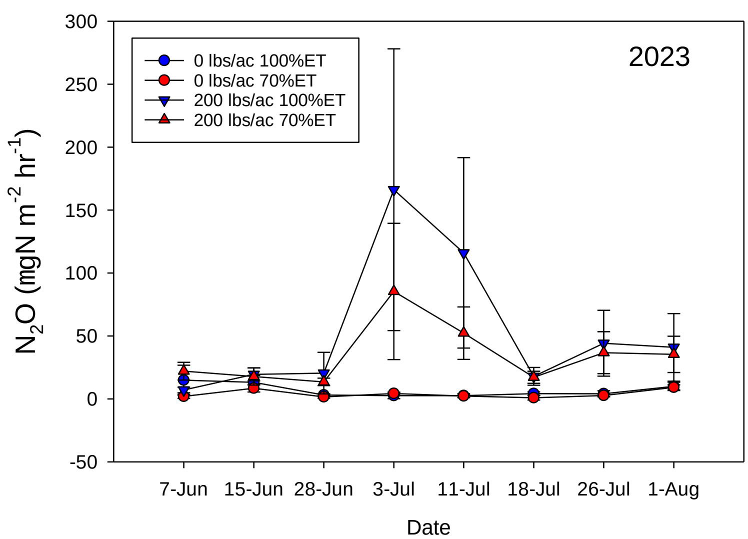
We found that the full water treatment had more cumulative nitrogen mineralization across the season compared to limited water, and that nitrogen fertilizer also increased nitrogen mineralization. We also found that nitrogen mineralization can vary from year to year with 2022 having overall more mineralization than 2021. Both increased water and nitrogen could have had a priming effect on the microbial community leading to increased activity and increased nitrogen mineralization.



Based on the high cumulative amounts of N mineralized, some of this N may have come from fertilizer that was immobilized by the soil microbial community and then mineralized.

Because our methods in 2021 and 2022 did not allow us to distinguish between fertilizer and soil organic matter nitrogen sources, we added labeled nitrogen fertilizer during the 2023 growing season. Using this labeled fertilizer, we will be able to see how much of the nitrogen accumulated by the plants comes from fertilizer compared to other sources.

Nitrogen fertilizer application rate is the single most important factor in determining nitrous oxide (N_2O) emissions from agriculture and represents an important means of cost-savings. In other studies from the front range of Colorado, limited irrigation reduced N_2O emissions 15-50%, but also reduced maize yield in some years.



Preliminary results from this study show a clear N_2O peak after banded fertilizer application in late June.

Both conserving water and reducing GHG emissions, will be increasingly important in developing sustainable agricultural systems in the arid Western U.S.

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