115th Annual
Field Day – 2024

USDA-ARS
Dryland Agricultural Research

and

CSU Wheat Field Day

Akron, Colorado
June 11, 2024

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Colorado State University

Contents

Agenda – 2024 Field Day

Tuesday, June 11, 2024
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, Akron Staff's Dryland Delicacies

8:25 Welcome to our Dryland Agricultural Research Station
Kyle Mankin (Research Leader, WMSRU, Fort Collins)
Peter Kleinman (Research Leader, SMSBRU, Fort Collins)

8:30 2024 Weather Update
Peter Goble (Colorado Climate Center, Colorado State University)

8:50 2024 Wheat Disease Update
Robin Roberts (Extension Agronomist, Colorado State University)

9:10 Wheat Stem Sawfly Research Update
Adam Osterholzer, Punya Nachappa (Entomology, Colorado State University)
Jeff Bradshaw (Doctor of Plant Health Program, University of Nebraska-Lincoln)

OUTDOOR FIELD TOUR – PEOPLE-MOVER WAGONS

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

TOUR 1	**TOUR 2**	**(** Starts Here*)**
ALL	ALL	2024 Wheat Variety Research Activities and Information Esten Mason, Sally Jones-Diamond (Colorado State University)
1*	2	Improving Nitrogen Use in Cropping Systems of Semi-arid Regions Tyler Donovan, Louise Comas, Huihui Zhang (USDA-ARS, Fort Collins, CO) Joel Schneekloth, Meagan Schipanski (Colorado State University)
2	3	On-Station Dryland Crop Rotation Management Research Kyle Mankin, Maysoon Mikha, Peter Kleinman, Grace Miner (USDA-ARS, Akron, CO)
3	4	Cowpea & Alternative Crop Rotation Research Marissa Spear, Jason Webb, Daniel Mooney, Joel Schneekloth, Jessica Davis (Colorado State University)
4	5	Kernza® / Intermediate Wheatgrass Study Grace Miner, Erika Peirce, Allison Hamm, David Poss, Peter Kleinman, Joel Schneekloth, Catherine Stewart, Kyle Mankin, & Justin Derner (USDA-ARS, Akron/Fort Collins, CO)
5	***1****	Wheat Stem Sawfly Management with Cultural Practices Dave Poss, Peter Kleinman, Kyle Mankin (USDA-ARS, Akron, CO) Tatyana Rand (USDA-ARS, Sydney, MT) Punya Nachappa, Adam Osterholzer (Colorado State University)

LUNCH – INDOOR FIELD DAY BUILDING

12:30 – 1:15 *Provided by our sponsors!*

RANGELAND RESEARCH DISCUSSION

1:15 *Integrating crop-livestock systems – what opportunities are there?*

We'll share some of what we're working on, and we'd also like to hear lessons learned from those who are making it work and how to increase adoption of this.

DISCUSSION LEADERS:
Justin Derner, David Smith, Kalyn Taylor, Erika Peirce, Larry Wagner, Fred Fox, Olivia Hajek (USDA-ARS, Fort Collins, CO & Cheyenne, WY)

2:00 Done!

NOTE:
CCA (Certified Crop Advisor) Credits are available (1 cr IPM, 2 cr Crop Management). Sign up at Registration Table.

Our Staff

Scientists
Dr. Peter Kleinman, Research Leader, Soil Sci.
Dr. Kyle Mankin, Research Leader, Agric. Eng.
Dr. Maysoon Mikha, Soil Scientist
*Dr. Grace Miner, Agronomist

Support Scientist
David Poss, Soil Scientist

Technicians
Cody Hardy, Agricultural Sci. Research Tech.
Stacey Poland, Agricultural Sci. Research Tech.
*Chris Brackett, Agricultural Sci. Research Tech.
*Susan Pieper, Agricultural Sci. Research Tech.

Administrative
Travis Vagher, Administrative Officer
Paul Campbell, Facilities & Equipment Specialist
*Becky Hutchens, Program Support Assistant
*Sienna Hawk, Secretary Office Automation

Postdoctoral Researcher
Dr. Shabaz Khan, Soil Scientist (CSU)

Seasonal Technicians
Emily Williams (ARS/CSU)
Vashti Winter (ARS/CSU)
Kinley Brown (ARS/CSU)
Caleb Poss (ARS)
Kelbi Schwartz (ARS)
Taylor Benish (CSU)
London Breese (CSU)
Molly Porteus (CSU)
Addison Weis (CSU)

CSU Staff
Joel Schneekloth
Sally Jones-Diamond
*Jason Webb
Ed Asfeld
Cameron Lyon

New staff!

Thank You Sponsors!

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Welcome to our Dryland Agricultural Research Station

Dr. Pete Kleinman

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

Dr. Kyle Mankin

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

Welcome to our 115th 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 designated 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, the late Wayne Shawcroft, our long-trusted agricultural meteorologist, began work at the Station; 66 years later, we honor his legacy of research and service.

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 hired an agronomist, Dr. Grace Miner, to keep Akron on the cutting edge of nutrient management research. Soon, we will be interviewing for a weed scientist. Last winter, we introduced the seminar series, Akron's Dryland Conversations. We will continue with these conversations this winter. 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

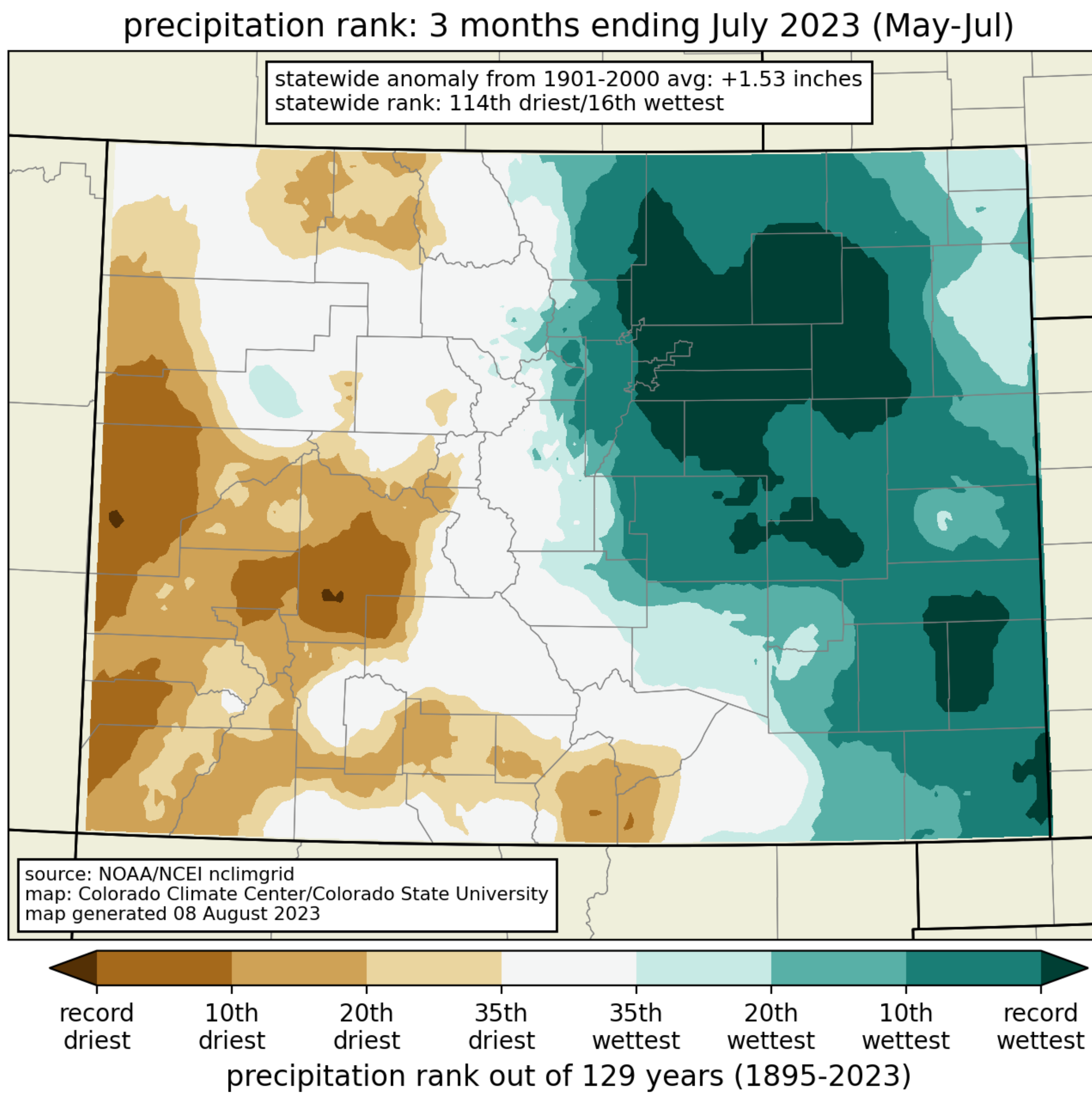
Pete Kleinman

peter.kleinman@usda.gov

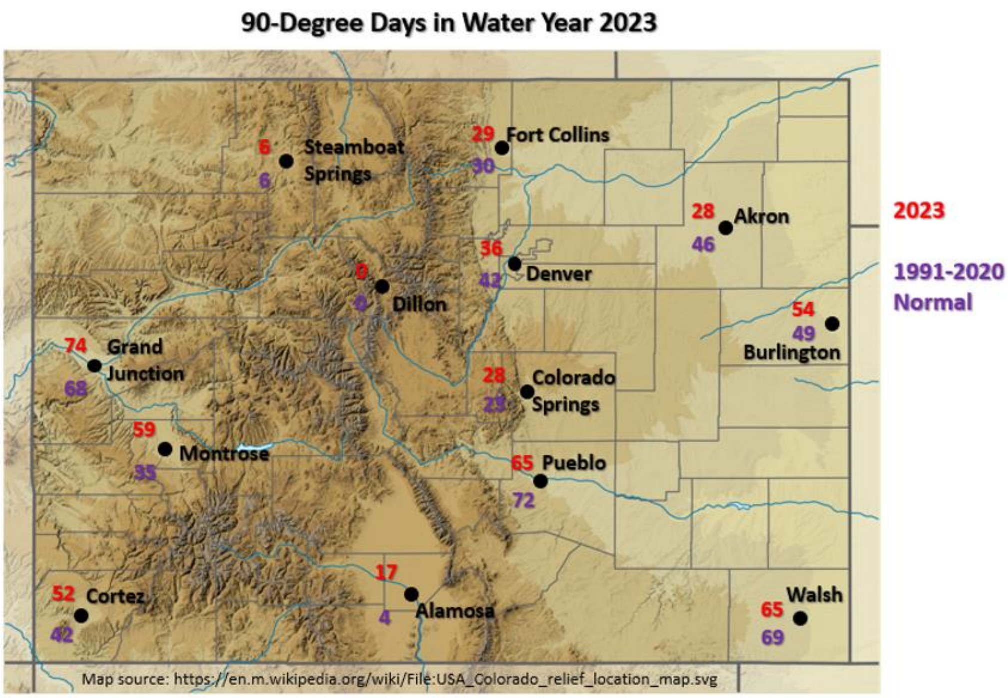
2023/2024 Weather Events and Where We Go from Here

Dr. Peter Goble

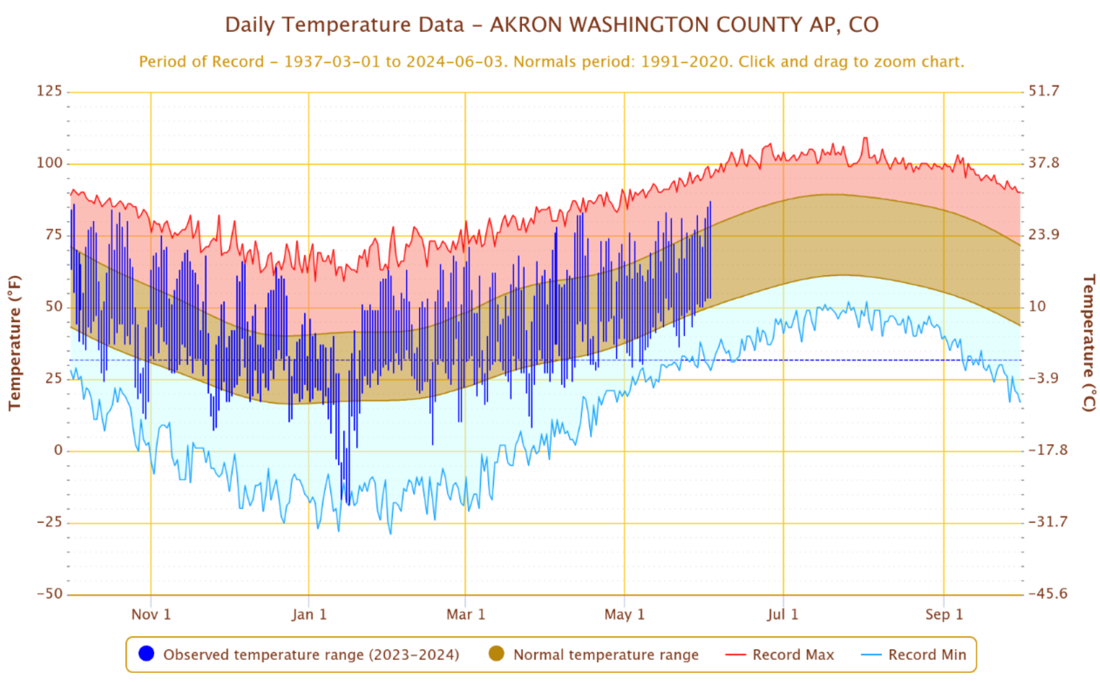
Colorado Climate Center, Colorado State University



Last summer was marked by some of the wettest conditions on record in Akron and a record number of severe weather and hail reports!

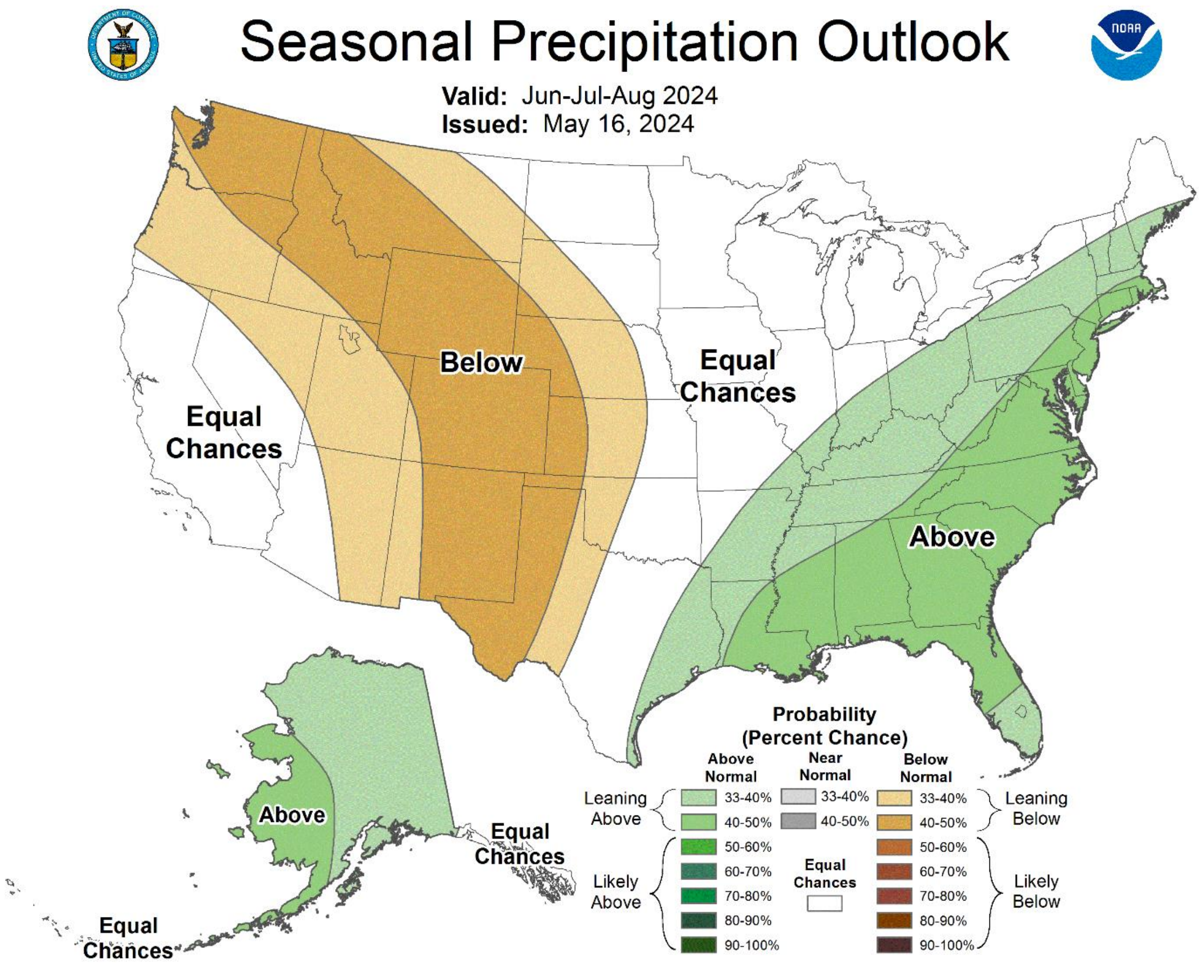


Last summer was also cool by recent historical standards, with far fewer than normal 90-degree days.

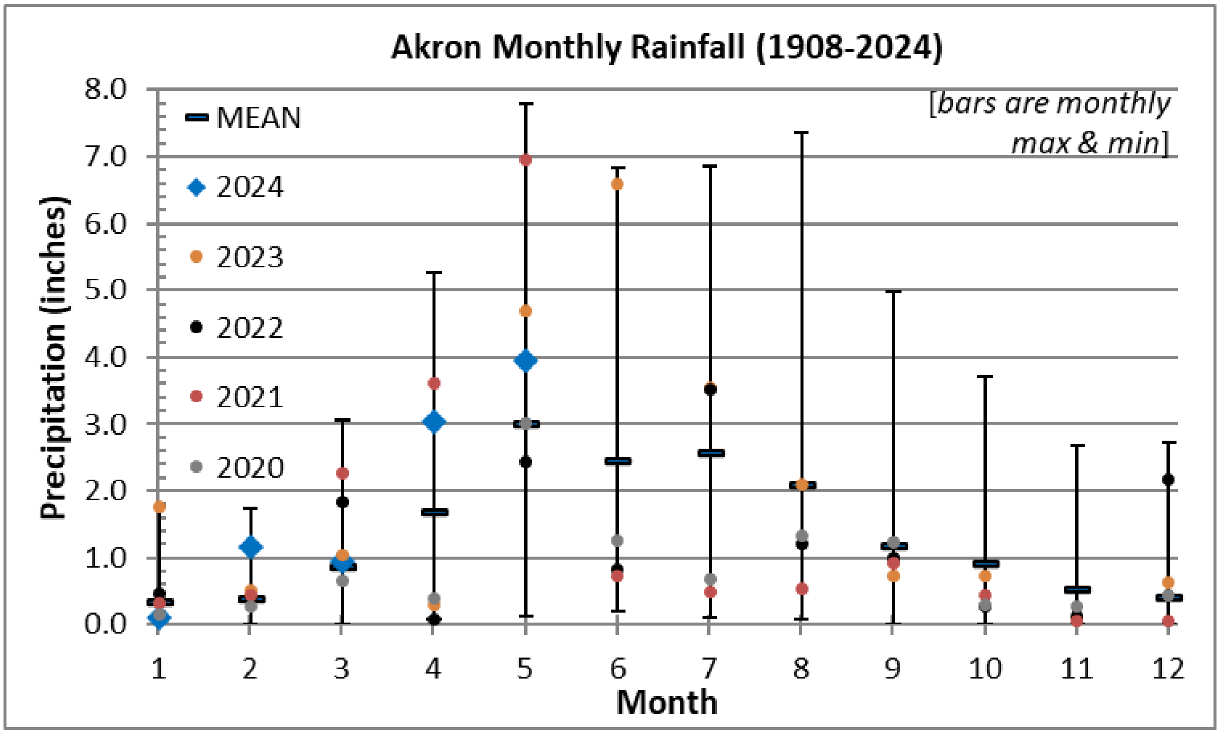


We experienced multiple record cold temperatures in the second and third week of January 2024, but with the exception of those two weeks, it was a mild fall and winter!

The April and May rains came right on schedule this year, and we are sitting just above average for moisture this calendar year. That may be about to change.



Seasonal forecasts show an unusually confident prediction for a drier than normal summer. What is to blame? La Niña? The North American Monsoon? Tune in to learn more!



(figure courtesy Dave Poss, Kyle Mankin)

2024 Wheat Disease Update

Robin Roberts

Extension Agronomist, Colorado State University

Risks, Management, and Effects of the *Fusarium* pathogen on winter wheat

Robyn Roberts

The Fusarium pathogen

Last year, an uncommon disease called Fusarium head blight (FHB, also known as head scab) appeared in Colorado wheat growing areas. This disease is caused by several species of fungi, but primarily *Fusarium graminearum* in cereals. The pathogen requires wet conditions to cause disease, so FHB is more common after significant, prolonged rainfall, much like what we encountered in late May-early June last year. Fusarium prefers warm temperatures (~75-85°F), but under extended wet conditions the fungus can be active at cooler temperatures. The fungus infects flowers, so the timing of the wet, warm weather with flowering last year provided optimal conditions for disease development.

Figure 1. Fusarium head blight (scab) symptoms on wheat. Note light brown spikelets contrasted against green heads.

Fusarium head blight

Symptoms of FHB include individual bleached spikelets on green heads (**Figure 1**). Pinkish-orange fungal spores may also be visible. Importantly, not only does FHB cause yield and quality losses, but the pathogen also produces a mycotoxin called deoxynivalenol (DON) which is toxic to people and livestock. Elevated levels of mycotoxin can accumulate even under minor disease conditions, and high numbers of damaged, wrinkled, or 'tombstone' grains may indicate high levels of mycotoxin. The spores produced from the initial infection can produce additional spores that infect other heads. Significant disease problems can therefore occur if wheat stands are uneven with late flowering tillers.

Infected corn or wheat residue can be a significant source of inoculum, and due to the high levels of FHB last year there is likely significant inoculum present in the environment to start disease this year.

Managing residue and applying a fungicide that is labeled for FHB at early flowering are the best control methods, in addition to genetic resistance. Fungicide efficacy tables may be found at the Crop Protection Network Site: https://cropprotectionnetwork.org/publications/fungicide-efficacy-for-control-of-wheat-diseases . Additionally, colleagues at the Fusarium Scab Initiative have developed a risk assessment tool to predict the likelihood of FHB to aid in decision making, available at https://tinyurl.com/2jcvcze9.

Fusarium root and crown rot

Planting FHB-infected seed from 2023 can also lead to root rot disease. Seeds can be infected with FHB with or without showing any symptoms, which also emphasizes the importance of planting clean seed. If infested seed is planted, root rot and crown rot may develop, as the fungus emerges and infects wheat plants directly from the seed (**Figure 2)**. Prolonged drought stress coupled with high soil temperature in the fall promotes early disease development, so conditions last fall were favorable for disease development this spring. Once root and crown rot appears, there is no effective treatment since fungicides won't work once there are disease symptoms. Therefore, prevention is the best method for disease control, including using certified, clean, high-quality seed treated with fungicide. Since corn and other cereals are hosts of Fusarium, it is also important to implement crop rotation so that the inoculum does not build up in residue.

Figure 2. Fusarium root and crown rot symptoms. Note the pink stem, poor root development, and the brown, rotted roots and crown. *Left Photo: Tyler Benninghoven.*

Increasing Incidence and Severity of *Triticum mosaic virus* Disease

Lukas Migliano, Matt West, and Robyn Roberts

Viruses cause major economic losses to winter wheat. In Colorado, the two most common and agronomically significant viruses are *Triticum mosaic virus* (TriMV) and *Wheat Streak mosaic virus* (WSMV). Symptoms of plants infected with either of these two viruses include chlorotic streaks, mosaics, speckles, stunting, and early maturation (**Figure 1)**. A co-infection of these two viruses leads to more severe symptoms and overall losses.

Virus Incidence

Historically, WSMV has been the predominant virus in Colorado wheat crops. When TriMV was first reported, it was seen mostly in co-infections with WSMV. However, since 2021, the Roberts lab at Colorado State University has observed an increasing number of samples infected with TriMV only, and a decreasing number of samples with WSMV (**Table 1**).

Virus Transmission

The Wheat Curl Mite (WCM, *Aceria tosichella)* vectors both TriMV and WSMV, and can pick up the viruses from infected plants during feeding and transfer them to healthy ones. Weather impacts mite activity which therefore impacts disease transmission. During periods of hot, dry weather, the wheat curl mite actively seeks out water and moves more frequently between plants. Additionally, strong winds can blow the mites further distances and spread diseases. Conversely, cooler temperatures and rainfall tend to decrease the WCM activity and suppress disease spread.

Figure 2. Wheat plants co-infected with WSMV and TriMV.

Virus Management and Prevention

In addition to planting varieties resistant to WSMV and the WCM, volunteer wheat management is essential. The WCM overwinters inside volunteers or weeds left in fields between harvest and planting. The continuation of the ‘green bridge’ allows mites to survive from one field season to the next, feeding on the next season’s plants and transmitting viruses they acquired.

Table 1. TriMV incidence is increasing in field-collected, virus symptomatic samples sent to the Roberts lab for diagnostics.

Year	Total # Samples	WSMV	TriMV	WSMV+TriMV	% of samples with TriMV only
2021	32	4	1	3	3%
2022	6	0	0	5	0%
2023	17	0	16	1	94%
2024 (as of 5/21/24)	8	1	6	1	75%

Wheat Stem Sawfly Research Updates

Adam Osterholzer

Research Associate, Colorado State University

Dr. Punya Nachappa

Associate Department Head, Colorado State University
(www.csuwheatentomology.com**)**

The wheat stem sawfly (WSS) has been a pest of growing concern in Eastern Colorado since it was found in wheat fields in 2010 near New Raymer. Adult sawflies emerge from wheat stubble in spring while the crop is jointing and lay eggs over their flight period. This flight lasts 4-6 weeks. The eggs hatch and develop into larvae that chew the interior pith of the growing wheat stems. As the crop dries, the larvae create a chamber near the root crown and cut the stems, causing lodging before the crop is harvested.

A statewide survey of WSS infestation has been conducted since 2013 to determine the scope of infestations across the state. Changes to the pest's range are also monitored. Approximately 100 sites are surveyed each year after the WSS flight has completed, with the number of sites collected from each county being proportional to the amount of wheat grown in the county. Collection sites are wheat fields directly adjacent to the previous year's wheat stubble, and each site is a minimum of 10 miles apart. For each site surveyed, 100 tillers are collected and dissected to check for the presence of WSS larvae. The percentage of infested tillers is reported for each sample location, with low infestation being less than 10% of total tillers having WSS infestation, medium having between 10%-50% infestation, and high infestation being any site with more than 50% of tillers infested.

For the 2023 survey, we observed a departure from this trend. There was a significant decrease in the proportion of sites with high infestation. We saw percentage increases for sites that had no infestation and low/moderate infestation. The high levels of precipitation in CO last year are the suspected cause of this reduced infestation. The range of WSS increased in 2023, despite the decrease in overall infestation. For example, we found sawfly larvae in both Baca and Boulder counties, neither of which had WSS present in 2022.

Table 1: Number of Colorado wheat fields in each infestation category from 2013-2023.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Not Infested	56	50	32	81	42	46	41	33	44	34	17
<10%	20	30	48	11	36	26	29	41	33	15	25
10-50%	13	15	16	4	13	12	22	20	20	24	19
>50%	5	5	3	3	5	12	14	11	3	21	4
Total Sites	94	100	99	99	96	96	106	105	100	94	65

Select CSU Wheat Stem Sawfly Research Highlights

Wheat stem sawfly growing degree-day or phenology model

We developed a growing degree-day (GDD) model based on 13-years of adult population data collected at New Raymer and Orchard to predict the timing of adult emergence and peak abundance. This model is based on temperature and precipitation. We predict the first adult appearance at 148 DD, adult population peak at 224 DD and decline at 3549 DD. We recommend scouting before 148 DD. On average the date for WSS emergence in Colorado is May 12th, so it is valuable to start scouting around late April. There is a difference of only 92 DD between emergence (148) and population peak (241), this is typically achieved around two weeks in Colorado. The average date of population peak was May 28th.

Screening for resistance to WSS in wild wheat species

Colorado State University teamed up with the Wheat Genetic Resource Center (WGRC) at Kansas

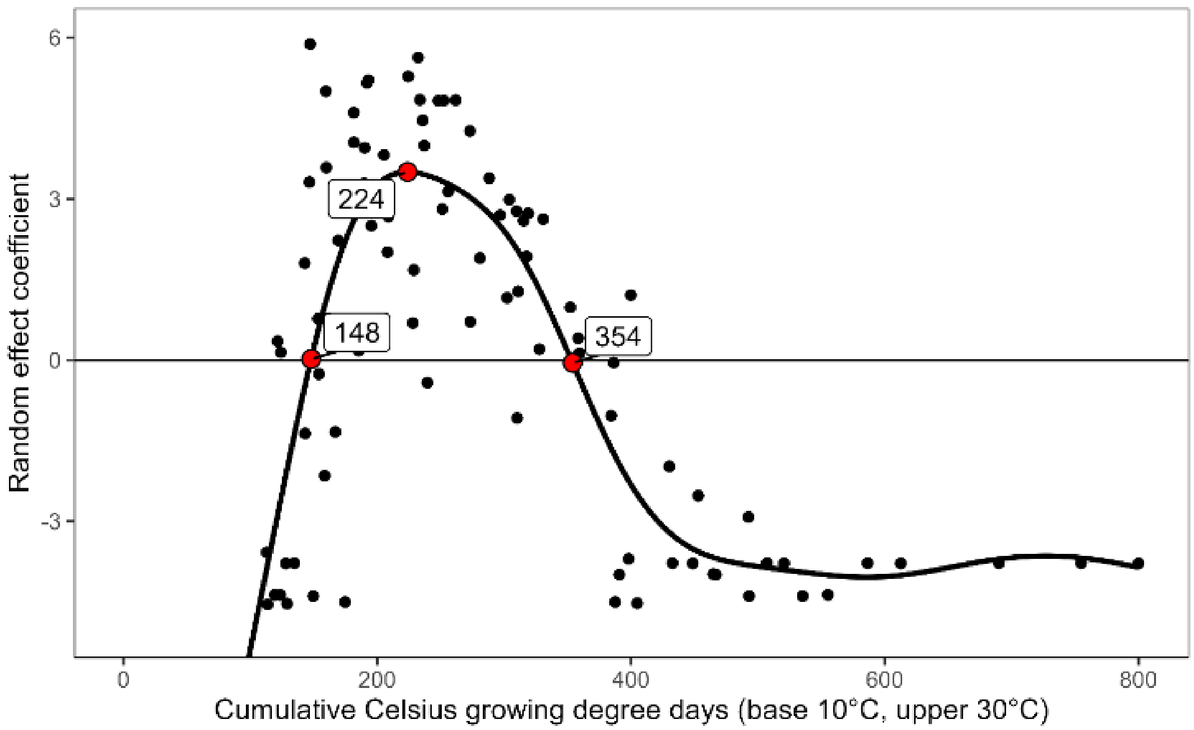


Fig. 1. Wheat stem sawfly growing degree-day model.

State University to explore potential resistance traits to the WSS in wild wheat relatives. We have identified *Triticum turgidum* and *Aegilops tauschii* as good candidates for further evaluation and integration into wheat breeding programs.

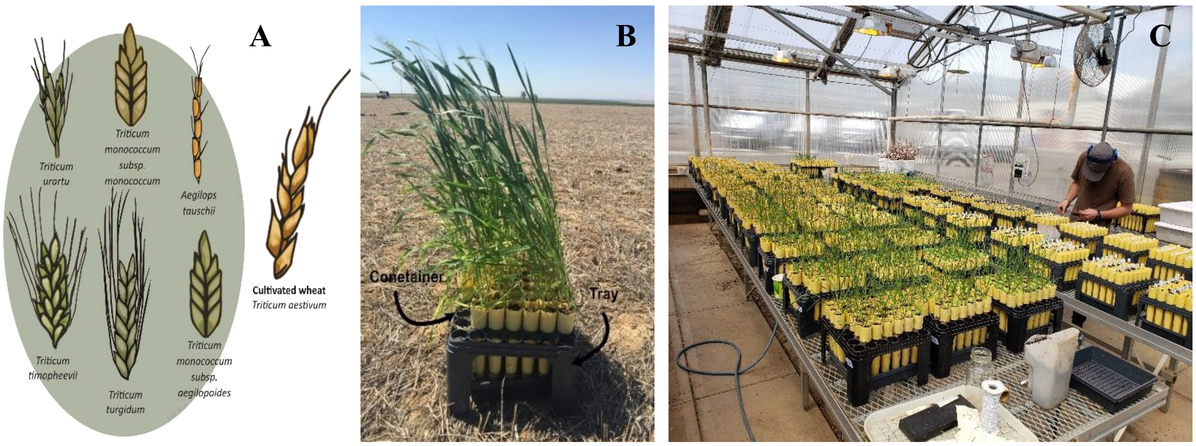


Figure 2. Screening for sources of WSS resistance in wild wheat species. A) wild wheat species, B) cone-tainer approach, and C) wheat lines being grown in the greenhouse. Picture credit: Erika Peirce.

Biological control using novel endophytic entomopathogenic fungi:

We found natural infestation of an entomopathogenic (insect-infecting) fungi on WSS larvae in New Raymer in 2022, which was identified as *Fusarium* spp. This is the first report of *Fusarium* spp. infecting sawflies in Colorado. We have begun characterizing the fungi and evaluating their potential as biocontrol agents.

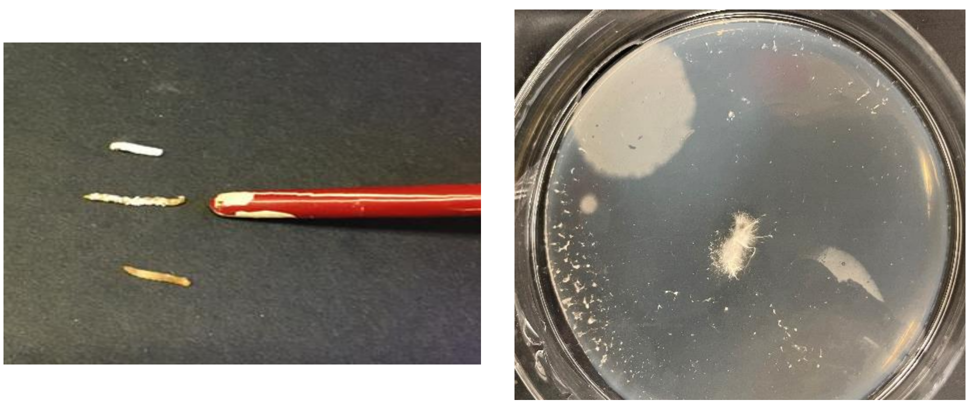


Figure 3. Wheat stem sawfly larvae found to be naturally infested with endophytic fungi, *Fusarium* spp. Specimens were obtained from New Raymer.

Acknowledgements

We thank the members of the CSU wheat entomology team for collecting and processing samples, and the Wickstrom and Mertens families for the use of their fields in New Raymer and Orchard. Funding support from Colorado Wheat Administrative Committee, FFAR and USDA-ARS.

Tour Stop: Wheat Field Day,
2024 Updates from the CSU Crops Testing Program

Sally Jones Diamond, Jason Webb, Ed Asfeld

Director & Field Agronomists, Crops Testing Program, Colorado State University
(https://csucrops.com/**)**

Esten Mason

Wheat Breeder and Project Leader, Colorado State University

Introduction

The CSU Crops Testing Program conducts the Official Variety Trials (OVT) for Colorado. We provide unbiased and reliable information to Colorado farmer to help them make better variety decisions. We currently conduct on-farm and small-plot variety trials for grain and forage sorghum, winter wheat, pinto beans, black-eyed pea, proso millet, sunflower (confection and oil), corn (grain and silage), and winter canola. We also conduct agronomy trials and test new foliar and soil applied products (including fertilizers and microbiologicals) coming onto the market for use by farmers producing the above-mentioned crops.

We work closely with USDA-ARS Research Center staff who help us conduct our research trials for the benefit of CO producers, industry, and other researchers.

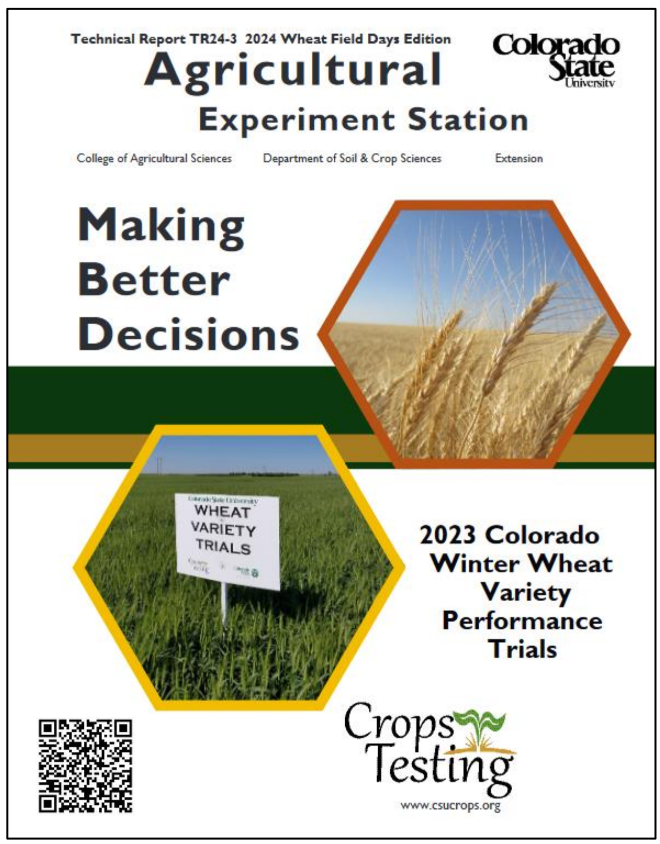
Updates

We hired a new agronomist in our program in February, Jason Webb. He is responsible for coordinating and assisting in the management of crop variety and agronomy trials. Jason assists in public presentations on research results and planning Extension outreach events. He is particularly interested in black eyed pea and soil fertility research. He has worked for over 25 years in the crop input, dry bean, and research industries. Jason has a B.S. in Agronomy from The Ohio State University and currently serves on the Colorado CCA Board.

Due to the success and adoption of black-eyed pea in Colorado, we have begun to work toward restarting a cowpea breeding program at CSU. We are in our second year of making crosses and are seeking additional funding toward that endeavor.

We are getting close to harvest for our wheat variety trials, those results will be posted on our website at csucrops.org. Our *Making Better Decisions* Report will be updated with 2024 harvest results and published in August. The current version of our report is available via the QR code in the bottom left of the cover page photo shown to the right.

If it is 6-11-24 and you have read all the way to this portion of the document, first – thank you. Second, please find Jason Webb for a prize (while supplies last).



Tour Stop 1: Improving Nitrogen Use in Cropping Systems of Semi-arid Regions

Tyler Donovan[1,2], Louise Comas[1], Joel Schneekloth[3], Meagan Schipanski[2], Huihui Zhang[1]

[1]Water Management and Systems Research Unit, USDA-ARS, Fort Collins, CO
[2]Department of Soil and Crop, Colorado State University
[3]Colorado State University Extension, Akron, CO

Plant nitrogen requirements are particularly uncertain when water is limited because of the interactive effects of water and nitrogen on plant growth, nitrogen mineralization, and plant nitrogen uptake. Evidence suggests that a major source of nitrogen for agronomic crops is nitrogen mineralization, a natural process in soil through which microbes make nitrogen available to the cropping system. To manage this nitrogen source, however, many details are needed, including the seasonal timing of when this nitrogen source is available and how much mineralized nitrogen is available under different water and fertilizer levels. Furthermore, there is uncertainty about how extra nitrogen fertilizer affects crops when water is limiting. Extra nitrogen can sometimes increase a crop's ability to handle water stress but can also decrease grain production.

To understand water and fertilizer controls on mineralized nitrogen rates in maize, we measured soil enzyme activity (associated with total or gross nitrogen mineralization) and net mineralized nitrogen under full and near-dryland levels of water availability and three levels of nitrogen fertilization addition, low (20 lbs/ac), optimal (200 lbs/ac), and excessive (245 lbs/ac), during the 2021 and 2022 growing seasons.

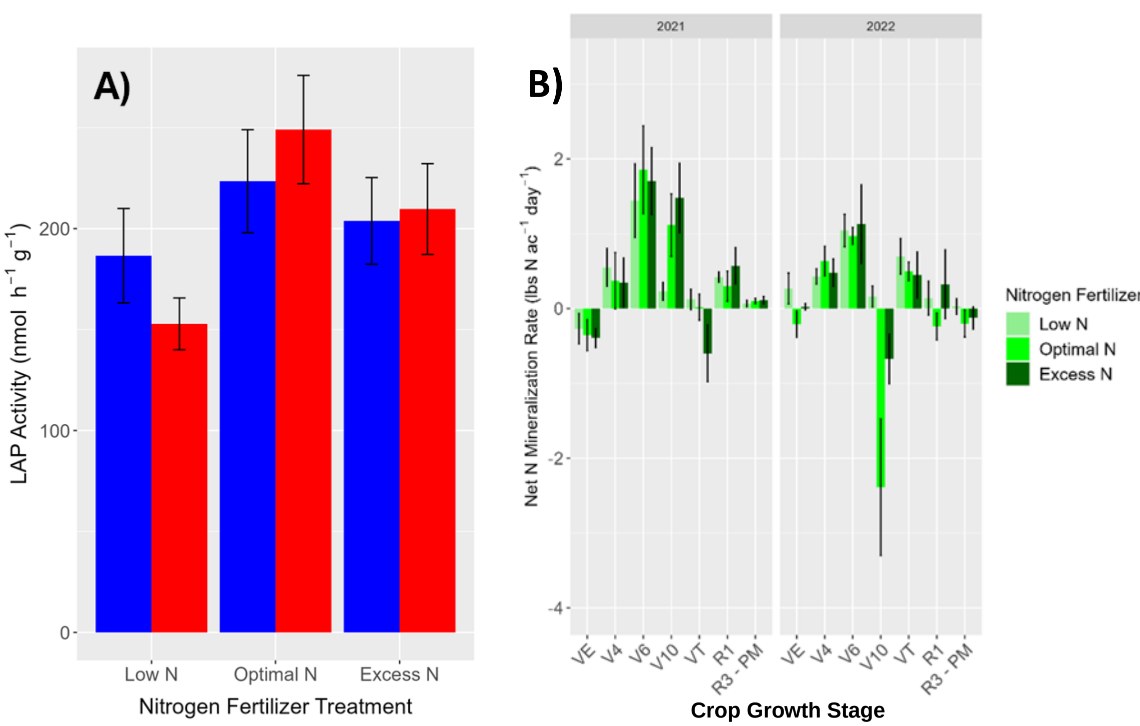


Figure 1. A) Enzyme activity (L-leucine amino peptidase, LAP) averaged across the 2021 and 2022 seasons. Blue bars indicate full water and red bars limited water availability. B) Net nitrogen mineralization across both seasons averaged across water treatments.

enzyme activity was not affected by water availability and increased with N fertilizer rate for both irrigation treatments. However, we found that net nitrogen mineralization was highest early in the growing season when plant nitrogen uptake rates are low, thus showing asynchrony between availability of mineralized nitrogen and crop demand.

Additionally, grain production and water and nitrogen use was assessed during the 2021, 2022, and 2023 growing season in maize under full and near-dryland water availability and six levels of N fertilizer from 20 – 245 lbs/ac. Water use efficiency (grain yield ÷ total crop water use) and nitrogen fertilizer use efficiency (grain ÷ N fertilizer rate) were calculated. Our data shows a proportional increase in grain yield as nitrogen fertilizer increases when water is fully available. However, when water was limiting, higher applications of nitrogen fertilizer tended to reduce grain yields and water use efficiency.

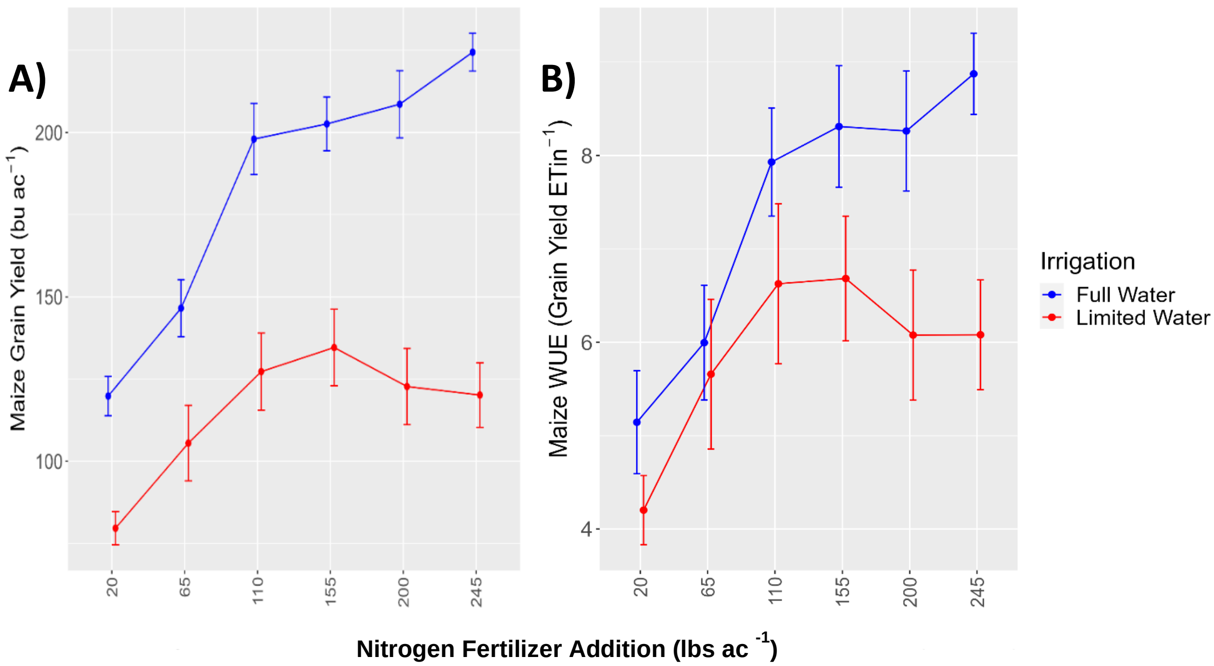


Figure 2. A) Grain yield and B) water use efficiency (WUE) for both levels of water availability and all six levels of nitrogen fertilizer addition averaged across the 2021, 2022 and 2023 seasons.

These results highlight the need to adjust nitrogen fertilizer rate based on water availability and plant growth potential to maximize yields and water use efficiency, as well as economic fertilizer use. Although maize nitrogen uptake increased with fertilizer additions for both water availabilities, under limited water availability, the increased nitrogen accumulation in the plants did not increase yield, and, at high fertilizer addition, tended to decrease yield. A potential explanation of this decrease is that increased application of fertilizer under low water availability may increase plant growth and water use early in the growing season leading to more severe water limitations during grain fill. Finally, more work is needed to explore how crop management might be modified to support the potential use of mineralized nitrogen as a nitrogen source for maize.

Tour Stop 2: On-Station Dryland Crop Rotation Management Research

Kyle Mankin, Peter Kleinman, Maysoon Mikha, Grace Miner

Agricultural Engineer, Soil Scientist, Soil Microbiologist, Agronomist
USDA-ARS, Akron, CO

Alan Linnebur, Doug Schmale

Customer Focus Group Leaders & Dryland Producers

Long History, New Approach

The Akron dryland agricultural Research Station has conducted on-station research since the first plot studies were established in 1909. As we look for the “next big thing” to improve productivity, net returns, and sustainability of dryland crop production, we keep looking for ways to streamline our timeline from new ideas to useable on-farm practices. Here’s what we’re doing.

Akron Dryland Conversations

Where do we get new research ideas? Often, they come directly from conversations with producers. This year, we introduced the “Akron Dryland Conversations” series at the Research Station. We bring in 3-4 experts, Pete and Kyle ask the experts questions, the experts present the latest science and practices, and then there’s lively back-and-forth conversation. This past season, we had three Conversations:

- Understanding and Managing Herbicide Resistant Weeds in Dryland Farming (December)
- Millet: It’s Not Just for the Birds… Breeding, Marketing, and Production (January)
- Nutrient Management in Dryland Agriculture: Challenges and Opportunities (March)

These are truly conversations. The ideas for topics come from producers. Then we assemble experts from industry, consulting, universities, and ARS to share their viewpoints. Producers and experts in the audience also weigh in with insights, creative solutions, and more questions.

We will post these blog-style recordings so everyone can take advantage of these sessions, even if you can’t show up in person. Stay tuned for our Akron Dryland Conversations schedule next season. We’re looking to do 4-5 Conversations next season (let us know what topics we should feature!).

Plot to Field to Farm Research

Dryland production is risky business. So is ARS research, but we take our risks so you don’t have to. Our on-station research uses small plots to rigorously test lots of “new ideas”. Then we scale-up the most promising crops, rotations, and practices to the field-scale to work out how variable soils, topography, and on-site factors influence results. Finally, and importantly, we are exploring how we can take the next step to evaluate new cropping systems in collaboration with producers on their farms. The on-farm phase is a work in progress, so stay tuned for these results in future Field Days.

Small Plots (ACR). Our ACR (Alternative Crop Rotation) small-plot research maintains 66 different plots with 3 replications of each (total = 198 plots). This lets us test many crops, rotation sequences, and practices and see how they respond to climate over time. These crops and practices have changed over time since we started the plots in 1993. Currently, our plots are in these rotations (all no-till):

- Continuous: Alfalfa (3), Grass (3), Sweet Clover (2)
- 2-Year: W-F (28), W-M (6)
- 3-Year: W-C-M (9), W-C-CP (9), W-C-F (18), W-M-F (18), FT-M-F (9), W-F-M (9)

- 4-Year: W-C-M-F (24), C-M-W-W (12), W-M-C-F (12), W-C-M-FP (24), M-FP-W-W (12)
  ABBREVIATIONS: W-Wheat, C-Corn, M-Proso Millet, F-Fallow, CP-Cow Pea, FT-Forage Triticale, FP-Forage Pea. NOTE: Number in parentheses is # of plots.

Fields (ASP/BAU and others). Our ASP/BAU (Aspirational vs. Business-as-Usual) field-scale research is designed to evaluate how yields and net returns are affected by several factors:

- crop rotation (W-C-M-F vs. W-F),
- tillage (no-till vs. reduced-till),
- climate (precipitation and temperature across years of the study), and
- precision management (each ASP field was divided into Low, Medium, and High yielding zones using prior yield history for that field).

We started this research in 2018 and have completed 5 years of data collection. So far, the two key results (very preliminary) are:

- **wheat yield after fallow was not reduced** by the 4-year rotation (… adding a third crop every four years did not reduce wheat yield **as long as it followed a fallow period**), and
- **wheat, corn, and millet yields responded to Nitrogen rate** in the precision management treatments (High > Medium > Low) **but only in higher-rainfall years**.

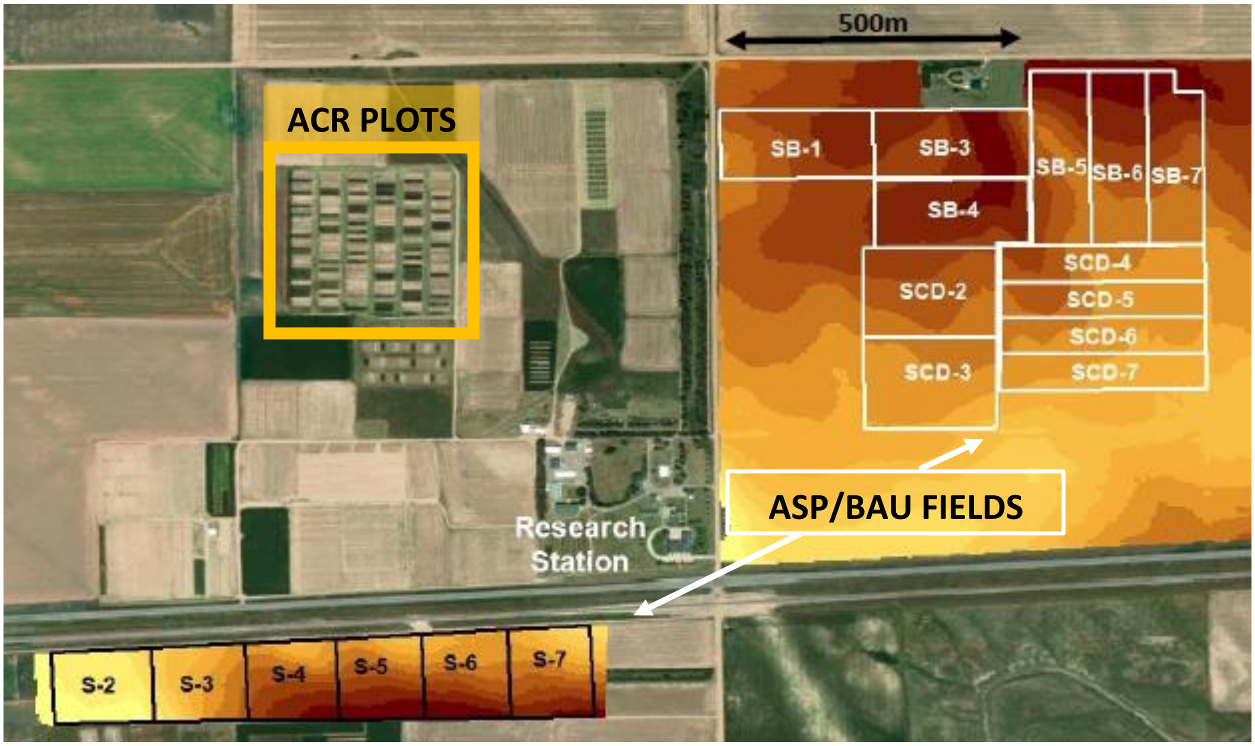


Figure 1. Akron Research Station dryland crop rotation research map showing out ACR (Alternative Crop Rotation) plots and ASP/BAU (Aspirational/Business-as-Usual) fields with topo contours.

Acknowledgment

We would like to acknowledge the Akron research location employees (David Poss, Cody Hardy, Paul Campbell, Stacey Poland, Chris Brackett, Susan Pieper, Carolyn Brandon, Sienna Hawk), post-docs (Shabaz Khan, Sushant Mehan), term and seasonal employees (Cameron Lyon and others) and many others over the years for their hard work and dedication to Akron research projects.

Tour Stop 3: Cowpea Potential in Dryland Cropping Systems

Daniel Mooney, Marissa Spear, Joel Schneekloth, Jessica Davis

Colorado State University

Introduction In Eastern Colorado, introducing alternative pulse crops (grain legumes) into crop rotations to counter the rising costs and management complexities of fallow has potential to increase farm profitability and improve soil health while minimizing environmental impact. Many pulse crops have low water and nutrient requirements, provide soil nutrient cycling benefits, and can provide risk-reducing options, as they can be used for forage or grain. At the USDA – Central Great Plains Agricultural Research Station in Akron, our research team is evaluating environmental and economic outcomes for 3-year crop rotations including a standard fallow rotation along with alternative rotations with millet or cowpea as a fallow replacement. It is part of a USDA Pulse Crop Health Initiative (PCHI) project.

Standard:	Wheat	Corn	Fallow
Alternative 1:	Wheat	Corn	Millet
Alternative 2:	Wheat	Corn	Cowpea

We are conducting in-depth evaluations of environmental outcomes by measuring water use efficiency, soil health metrics including nitrogen cycling and soil organic matter, and total resource use from farm to plate. Additionally, economic viability of each rotation is being assessed by comparing profitability of rotations that contain pulse crops to standard rotations using break-even analysis. Here, we present some initial economic comparisons of cowpeas as a rotation crop as a replacement for fallow or millet.

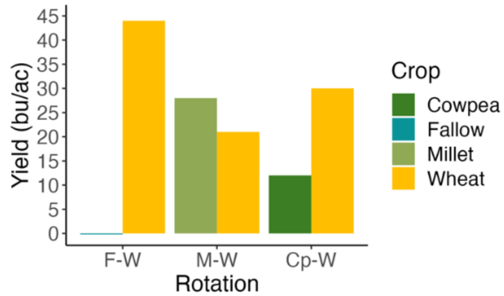
Project Highlight: *Break-Even Analysis for Cowpea as a Rotation Crop*
Break-even analysis is a tool that can help dryland wheat farmers evaluate whether they should replace fallow with a rotation crop and which crop to choose. This "project highlight" shares results of a simplified comparative break-even framework applied to dryland wheat in Eastern Colorado. We work through two break-even analysis examples which assess the potential for cowpea to (1) replace fallow in a Wheat-Corn-Fallow (W-C-F) rotation and (2) replace millet in a Wheat-Corn-Millet (W-C-M) rotation.

Comparative break-even analysis shows how relative changes in yields, prices, and/or costs for alternative options (fallow, millet, cowpea, etc.) affect the profitability of a cropping rotation. In addition, it considers the effect of those alternatives on subsequent wheat yields. When fallow is replaced with millet or cowpea, there is a wheat yield penalty due to less available soil moisture. Corn yields may also be affected within these rotations, as outlined in the full report. The impact of a change in rotation on a farmer's "bottom line" is summarized by a metric called *incremental profit*.

Incremental profit is interpreted as the expected *change* in profit, relative to a baseline or status quo scenario. Incremental profit is calculated as "total positive changes" minus "total negative changes." Positive changes can include increased revenues or decreased costs. Negative changes can include decreased revenues or increased costs. Partial budgets are the economic tool that we use to calculate incremental profits for a proposed change in cropping rotation. A positive value for *incremental profit* indicates the proposed change is expected to improve a farmer's bottom line, whereas a negative *incremental profit* indicates the farmer is likely better off without making the change.

Yield Assumptions
Complete yield data from the PCHI field trials are not yet available, so we drew values from several different sources for this analysis. The expected crop yields in the examples (wheat after fallow, wheat after millet, millet after corn) are set to the long-run average yields for these crops in the USDA-ARS Akron experiment station dryland rotation field trials (1994-2017). The cowpea yield values are from performance trials conducted by CSU Crops Testing (https://csucrops.org/bep/).

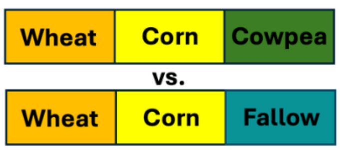
The expected wheat yield after fallow is 44 bu/ac, while the expected wheat yield after millet is 21 bu/ac, for a yield penalty of 23 bu/ac. The expected wheat yield after cowpea is 30 bu/ac, for an expected 14 bu/ac yield penalty as compared to fallow. Consistent with emerging results from USDA-ARS trials, wheat following cowpea appears to have a lower yield penalty by about 7-10 bu/ac compared to wheat following millet.



Price and cost assumptions

The price and cost assumptions are highly simplified. Wheat and millet price ranges are from the USDA NASS Colorado Agricultural Statistics bulletin. Millet prices approximate recent prices observed in Eastern Colorado. Wheat costs come from the CSU Crop Budgets. For simplicity, we assume fallow costs are 10% of wheat costs based on the University of Nebraska crop budgets. We assume costs for millet are 80% of wheat costs and cowpea costs are 120% of wheat costs.

Example #1: *Potential for cowpea to replace fallow in a W-C-F rotation*



We begin with the question, "Is it profitable for cowpea to replace fallow, if the expected cowpea yield is 12 bu/ac and the expected wheat yield penalty is 14 bu/ac?" For this to hold, the incremental profit for replacing fallow with cowpea in a W-C-F rotation must be positive. The incremental profit is positive when cowpea revenues plus decreased fallow costs are greater than the forgone value of the wheat yield penalty plus cowpea production costs.

Partial Budget for Example #1 (Potential for cowpea to replace fallow in a W-C-F rotation)

Increased Revenue	$/ac	Decreased Revenue	$/ac
Cowpea Production ($0.50/lb x 12 bu/ac x 60 lb/bu)	$360	Wheat Yield Penalty ($6/bu x Wheat yield penalty = 14 bu/ac)	$84
Decreased Cost	$/ac	Increased Cost	$/ac
Fallow Cost Savings	$14	Cowpea Production Costs (Assumed to be 120% of Wheat Production Costs)	$196
Total Positive Changes ($/ac) =	$374	Total Negative Changes ($/ac) =	$280
		Incremental Profit ($/ac) =	+$95

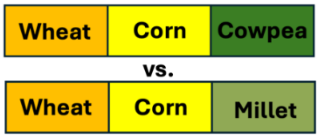
To evaluate how sensitive the result is to prices, we show the incremental profit for several combinations of cowpea prices and wheat prices below. Positive entries are shown in black and imply that replacing fallow with cowpea is profitable, given the assumed yields, prices, and costs.

Sensitivity of Incremental Profit to Cowpea and Wheat Prices
(Cowpea Yield = 12 bu/ac, Wheat Yield Penalty = 14 bu/acre)

		Wheat Price ($/bu)				
		$4.00	$5.00	$6.00	$7.00	$8.00
Cowpea	$0.30	($21)	($35)	($49)	($63)	($77)
Price	$0.40	$51	$37	$23	$9	($5)
($/lb)	$0.50	$123	$109	$95	$81	$67
	$0.60	$195	$181	$167	$153	$139
	$0.70	$267	$253	$239	$225	$211

Main takeaway: In cases where the assumed yields, prices, costs, and yield penalty effects approximate the value for your farm, replacing fallow in a W-C-F rotation with cowpeas might be profitable. The values for your farm, however, may differ markedly from those shown in the case study example and this same exercise should be repeated with more accurate values. Other limitations are discussed below.

Example #2: *Potential for cowpea to replace millet in a W-C-M rotation*



Next, suppose you already replaced fallow with millet, but wonder whether cowpea might be a more suitable rotation crop. We ask the question, "Is it profitable for cowpea to replace millet, if the expected cowpea yield is 12 bus/ac, the expected wheat price is $6/bu, and the expected wheat yield gain is 9 bu/ac for cowpea compared to fallow?" For this to hold, the incremental profit for replacing millet in a W-C-M rotation must be positive. The incremental profit is positive when the sum of cowpea revenues, increased wheat revenue, and millet cost savings are greater than the forgone millet revenue and cowpea production costs.

Partial Budget for Example #2 (Potential for cowpea to replace millet in W-C-M rotation)

Increased Revenue	$/ac	Decreased Revenue	$/ac
Cowpea Revenue ($0.50/lb x 12 bu/ac x 60 lb/bu)	$360	Forgone Millet Revenue ($0.15/lb x 28 bu/ac x 50 lb/bu)	$210
Wheat Revenue (Smaller yield penalty) ($6/bu x 9 bu/ac increase)	$54		
Decreased Cost	**$/ac**	**Increased Cost**	**$/ac**
Millet Cost Savings	$130	Cowpea Costs (Assumed to be 120% of Wheat Costs)	$196
Total Positive Changes ($/ac) =	$544	Total Negative Changes ($/ac) =	$406
		Incremental Profit ($/ac) =	+$139

The combinations of cowpea price and millet price that make replacing millet with cowpea profitable, given the assumed cowpea yield, wheat yield, and wheat price, are shown in black below. Entries in the table are increased overall returns to the rotation per acre. Entries that appear red and are enclosed by parentheses imply a negative incremental profit and switching to cowpea would not be profitable.

Sensitivity of Incremental Profit to Cowpea and Millet Prices
(Cowpea Yield = 12 bu/ac, Wheat Yield Gain = 9 bu/ac, Wheat Price = $6/bu)

		Millet Price ($/lb)				
		$0.05	$0.10	$0.15	$0.20	$0.25
Cowpea Price ($/lb)	$0.30	$135	$65	($5)	($75)	($145)
	$0.40	$207	$137	$67	($3)	($73)
	$0.50	$279	$209	$139	$69	($1)
	$0.60	$351	$281	$211	$141	$71
	$0.70	$423	$353	$283	$213	$143

Main takeaway: In cases where the assumed yields, prices, costs, and yield effects approximate the value for your farm, replacing millet in a W-C-M rotation with cowpeas might be profitable. Similar to Example #1, however, the values for your farm may differ markedly from those shown in this case study example and this same exercise should be repeated with more accurate values.

Further Information A full report will be available at the CSU Crops Testing website, along with a customizable Excel decision aid that will help you calculate break-even prices for these two examples based on values specific to your farm. Although this "study highlight" shows potential benefits to cowpeas as a fallow replacement, there are other limitations that must be considered. Markets for cowpeas are limited and producers should have a suitable contract with a processor. Non-yield effects (weed control, soil health, corn yield effects, etc.) should also be considered. The examples assume that the necessary equipment is available to farmers and only consider changes in variable costs. Implications for cash flow, risk position, crop insurance, or inflation are not considered but also important to the decision.

Link to Full Report and Continuing Cowpea Research: https://csucrops.org/bep/

Tour Stop 4: Kernza® / Intermediate Wheatgrass Study

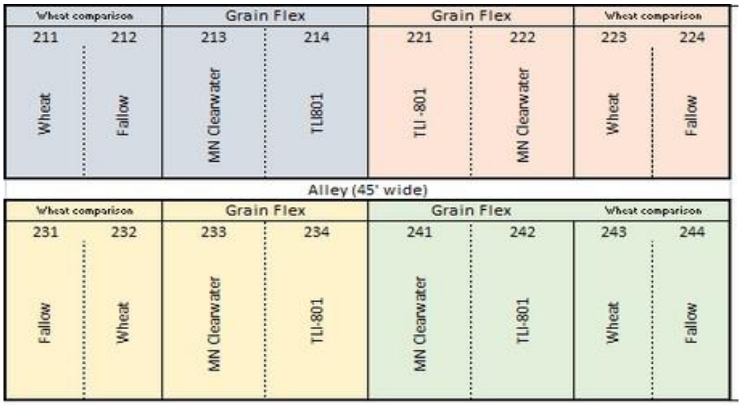
Diversification of Dryland Agriculture

Grace Miner, Erika Peirce, Allison Hamm, David Poss, Peter Kleinman, Joel Schneekloth, Catherine Stewart, Kyle Mankin, & Justin Derner

USDA-ARS, Akron, CO & Fort Collins, CO

Kernza® is a newly developed intermediate wheatgrass variety being bred toward grain production. As a perennial, Kernza® 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 or forage. Its emerging market is as a high value specialty grain (brewing, distilling, cereals, baking, and more), but is also a high-quality forage. 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. This research at Akron, initiated Fall 2022, is part of a coordinated, multi-location national ARS research initiative aimed at short-ordering our understanding of this novel perennial crop. Each location is growing two common Kernza® varieties, with three sequential planting years. Common, coordinated data is collected at each site related to **soil fertility, soil carbon, nutrient use, crop phenology and production, & grain and forage quality**. Each site has flexibility to add on measurements and questions related to the unique capabilities and constraints of that agroecosystem.

AKRON EXPERIMENTAL DESIGN, REPLICATED FOR 3 GROWING YEARS

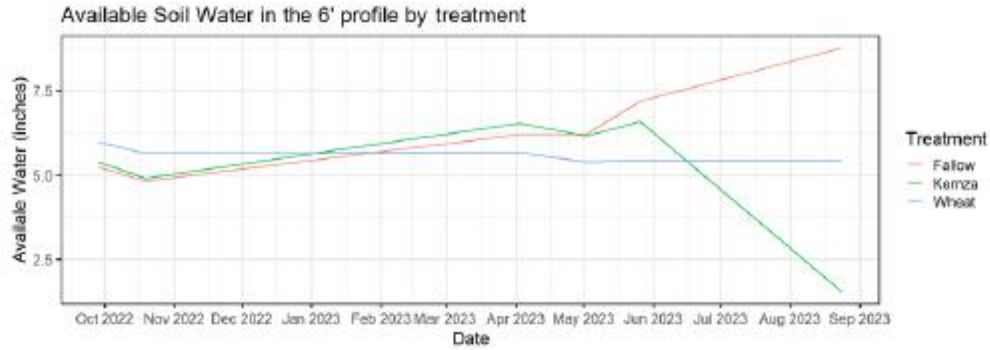


UNIQUE DRYLAND QUESTIONS

WATER

Key questions:

- Perennial water use vs wheat
- Changes in water use with stand longevity
- Cutting height/water capture
- Tolerance/avoidance of drought stress
- Impacts of perennials on subsequent cash crops



STRAW/FORAGE


	Kernza Straw	Wheat Straw
Protein	5.5%	4.6%
Neutral Detergent Fiber	74%	79%
Total Digestible Nutrients	50%	38%
Relative Feed Quality	78%	43%

WHEAT STEM SAWFLY

POTENTIAL REFUGE FOR PARASATOIDS TO CONTROL WHEAT STEM SAWFLY



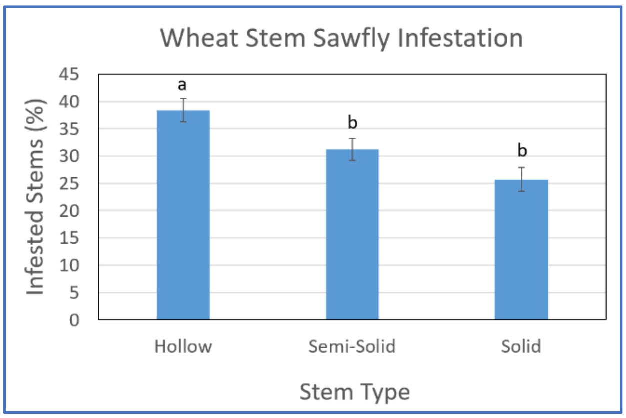
POST SAMPLING GRINS!

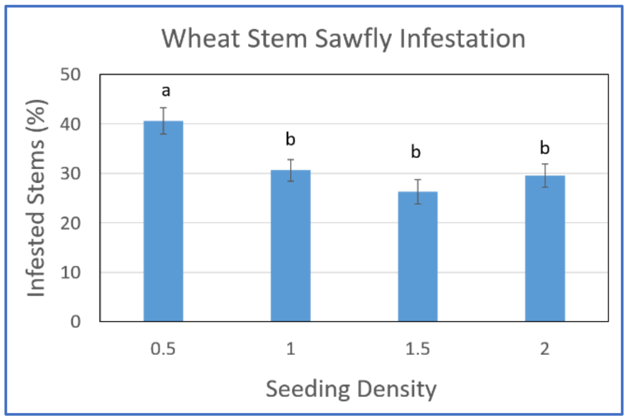
Tour Stop 5: Wheat Stem Sawfly Management with Cultural Practices

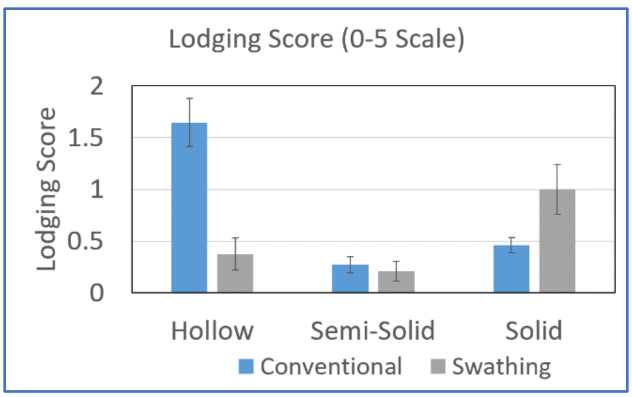
David J. Poss[1], Tatyana Rand[2], Punya Nachappa[3], Adam Osterholzer[3], Peter Kleinman[1], Kyle Mankin[1]

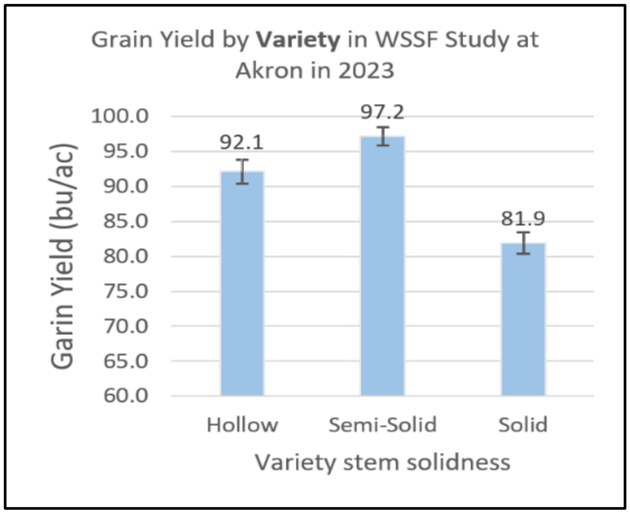
[1] USDA-ARS (Akron, CO & Fort Collins, CO)
[2] USDA-ARS (Sidney, MT)
[3] Colorado State University (Fort Collins, CO)

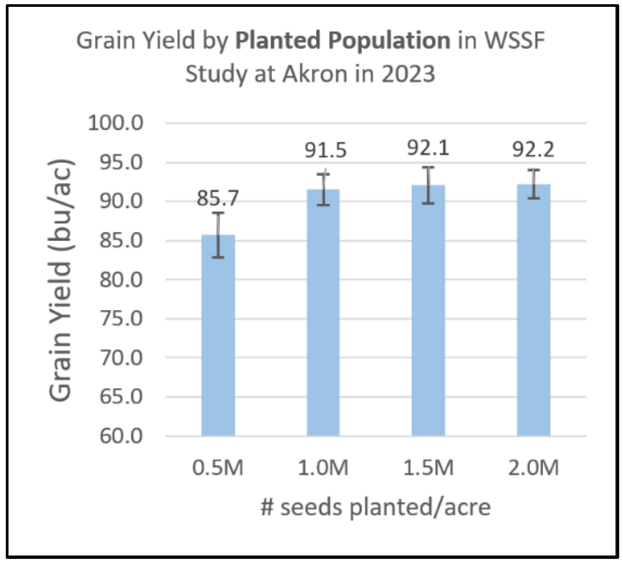
We established a study established in 2023 to investigate the possibility of increasing seeding rates as a cultural practice for managing Wheat Stem Sawfly (WSSF). We also investigated wheat varieties with different stem solidness ratings and the impact of harvest method on yield.

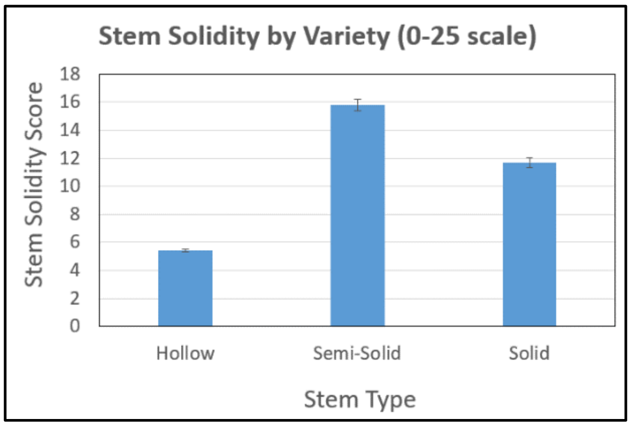


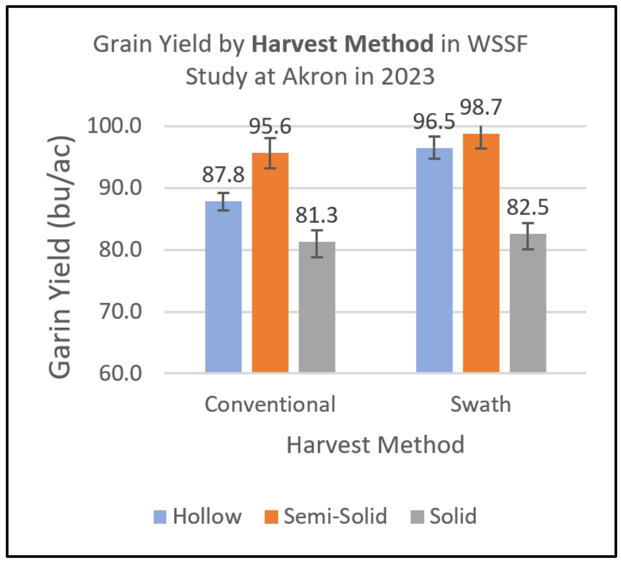





Grain Yield by **Variety** in WSSF Study at Akron in 2023
Garin Yield (bu/ac)
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
92.1
97.2
81.9
Hollow
Semi-Solid
Solid
Variety stem solidness


Grain Yield by **Planted Population** in WSSF Study at Akron in 2023
Grain Yield (bu/ac)
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
85.7
91.5
92.1
92.2
0.5M
1.0M
1.5M
2.0M
seeds planted/acre


Stem Solidity by Variety (0-25 scale)
Stem Solidity Score
18
16
14
12
10
8
6
4
2
0
Hollow
Semi-Solid
Solid
Stem Type


Grain Yield by **Harvest Method** in WSSF Study at Akron in 2023
Garin Yield (bu/ac)
100.0
90.0
80.0
70.0
60.0
87.8
95.6
81.3
96.5
98.7
82.5
Conventional
Swath
Harvest Method
Hollow
Semi-Solid
Solid

2023 Publications

Published

(USDA-ARS Akron Authors underlined)

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