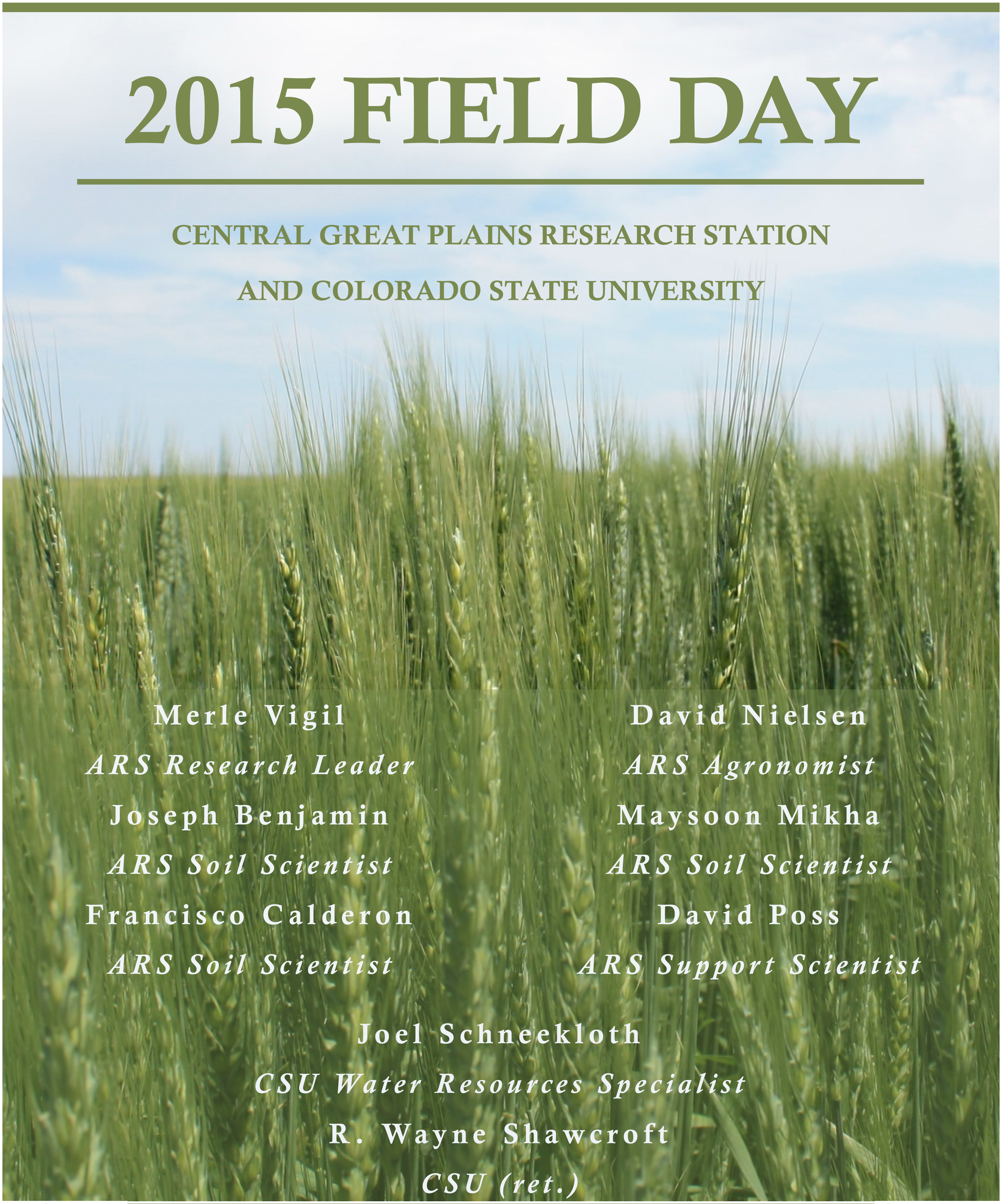

2015 FIELD DAY

CENTRAL GREAT PLAINS RESEARCH STATION
AND COLORADO STATE UNIVERSITY

Merle Vigil
ARS Research Leader

David Nielsen
ARS Agronomist

Joseph Benjamin
ARS Soil Scientist

Maysoon Mikha
ARS Soil Scientist

Francisco Calderon
ARS Soil Scientist

David Poss
ARS Support Scientist

Joel Schneekloth
CSU Water Resources Specialist

R. Wayne Shawcroft
CSU (ret.)

www.akron.ars.usda.gov

ANNUAL FIELD DAY

WEDNESDAY, JUNE 10, 2015

USDA-ARS CENTRAL GREAT PLAINS RESEARCH STATION
HIGHWAY 34, 4 MILES EAST OF AKRON, COLORADO

Registration Begins at 8:30 am with Coffee and Donuts
Program Starts at 8:55 am

Introductory Talks in Building #18

8:55-9:00 am	**Dr. Merle Vigil** Welcome
9:00-9:15 am	**Wayne Shawcroft** "Wheat Year Precipitation/Temperature Analysis 2015 Crop"
9:15-9:30 am	**Dr. Frank Peairs, CSU** "2015 Wheat Stem Sawfly Update"
9:30-9:50 am	**Jessica Swan** "Canola Marketing"
9:50-10:05 am	**Dr. Merle Vigil** "Canola Production Update"

Tour #1

10:10-10:25 am	**Dr. Maysoon Mikha** "Nitrogen Rates and Types in a Long-Term No-Tillage Cropping System"	Pan 2 Study Site
10:30-10:45 am	**Dr. Joseph Benjamin** "Wheat Yields in Rotations with Sunflower"	Linear move Sunflower rotation
10:50-11:05 am	**Joel Schneekloth** "Impact of Residue Removal & Tillage on Water Infiltration"	W Well/E of new Linear
11:15-11:30 am	**Dr. Francisco Calderon** "Update About Organic Wheat Research at the CGRPS"	Organic Plots
11:30-11:45 pm	**Dr. David Nielsen** "Cover Crop Biomass Production under Varying Water Availability"	ACR plot area
12:05-12:20 pm	**Break**	Seed House
12:30-1:30 pm	**Dr. Scott Haley and Dr. Jerry Johnson** "Making Better Decisions—the 2014 Colorado Winter Wheat Variety Performance Trial Results	Wheat plots, south of tracks
1:30 pm	**Lunch** "Have a Sandwich and Visit"	Building #18

Tour #2

10:15-11:15 am	**Dr. Scott Haley and Dr. Jerry Johnson** "Making Better Decisions—the 2014 Colorado Winter Wheat Variety Performance Trial Results	Wheat plots, south of tracks
11:25-11:40 am	**Break**	Seed House
11:50-12:05 am	**Dr. Maysoon Mikha** "Nitrogen Rates and Types in a Long-Term No-Tillage Cropping System"	Pan 2 Study Site
12:10-12:25 am	**Dr. Joseph Benjamin** "Wheat Yields in Rotations with Sunflower"	Linear move Sunflower rotation
12:30-12:45 pm	**Joel Schneekloth** "Impact of Residue Removal & Tillage on Water Infiltration"	W Well/E of new Linear
12:55-1:10 pm	**Dr. Francisco Calderon** "Update About Organic Wheat Research at the CGRPS"	Organic Plots
1:10-1:25 pm	**Dr. David Nielsen** "Cover Crop Biomass Production under Varying Water Availability"	ACR plot area
1:25 pm	**Lunch** "Have a Sandwich and Visit"	Building #18

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Morgan Woods

CSU Summer Students

Kierra Guy
Kelsey Guy
Lexi Thompson

WHEAT YEAR PRECIPITATION / TEMPERATURE ANALYSIS
2015 CROP

Dr. R.Wayne Shawcroft
Extension-Irrigation Agronomist
(Retired)

Central Great Plains Research Station
Akron, Colorado

Data through May 28, 2015

WINTER WHEAT--CROP MOISTURE YEAR

In the conventional Wheat-Fallow system, the moisture year for the wheat crop can be divided into two periods:
a **14-month Fallow Period** and a **10-month Growing Period.**
The **TOTAL WATER AVAILABLE** for the wheat crop depends on how much of the precipitation is stored in the soil during the fallow period or the **(% STORAGE EFFICIENCY)** ***and the*** **GROWING SEASON PRECIPITATION.**

The following tables compare the **FALLOW PERIOD** and the **GROWING PERIOD** conditions for the current wheat crop...to be **harvested in 2015.**

Summary of Fallow Period 14-month
(J,A,S,O,N,D,J,F,M,A,M, J,J,A) = 14-months
July 2013 -- Aug 20143

Month	Year	Fallow Precip in	106-year Average Precip	Departure
Jul	2013	1.59	2.624	-1.03
Aug	2013	2.92	2.137	0.78
Sep	2013	3.63	1.272	2.36
Oct	2013	1.07	0.924	0.15
Nov	2013	0.30	0.538	-0.24
Dec	2013	0.10	0.420	-0.32
Jan	2014	0.97	0.330	0.64
Feb	2014	0.39	0.353	0.04
Mar	2014	0.84	0.838	0.00
Apr	2014	1.49	1.638	-0.15
May	2014	3.81	2.896	0.91
Jun	2014	3.27	2.438	0.83
Jul	2014	2.28	2.623	-0.34
Aug	2014	4.94	2.170	2.77
Total		**27.60**	**21.201**	**6.40**

total months= 14

Growing Period Precip
10-Month Sep-June

Month	Year	Sep2014-Jun 2015 Precip	106-yr Ave Precip	Departure	Days of Snow Cover	Snow Depth in.
Sep	2014	3.48	1.30	2.18	0	0.0
Oct	2014	0.23	0.90	-0.67	0	0.0
Nov	2014	0.29	0.52	-0.23	4	4.5
Dec	2014	0.68	0.43	0.25	17	14.0
Jan	2015	0.33	0.33	0.00	26	4.0
Feb	2015	0.39	0.34	0.05	10	5.5
Mar	2015	0.36	0.81	-0.45	1	1.5
Apr	2015	1.67	1.65	0.02	1	2.0
May	2015	5.10	2.93	2.17	1	1.0
Jun	2015		2.43	-2.43	0	0.0
Total		**12.53** inches	**11.64**	**0.89**	60	32.5

total months = 10

28-May-2015 <Last Update

FALLOW PERIOD SUMMARY:

The **July '13 - Aug. '14** fallow period precipitation was **27.60 inches**, which ranks as the **7th wettest** fallow period in the 106-year record for the 1908-09 through 2013-14 records. This is **6.40 inches** above the average of 21.20 inches. The fallow period began with a slightly below average July, but heavy rains in Aug. '13 and, of course, the flood of Sept. '13 set up for a near record total. The fall and winter months maintained a steady moisture accumulation with good rain and snow in Oct. and Jan. March and April were both near average in rainfall. The summer rains (May-Aug '14) were well above average with over 14 inches of rain total. Overall the set-up for the 2015-crop could hardly have been better.

GROWING SEASON SUMMARY Sep '14-Jun '15: The *GROWING SEASON* precipitation for the **2015** crop **(through MAY 28, 2015)** has been **12.53 in.** which is **0.89 inches above the average of 11.64** inches. The *GROWING SEASON* precipitation for the current crop ranks as the **36th wettest** on record or the **71st driest** and this **does not include the *full* month of June**, which could increase this amount. Fall rainfall was substantial with the Sept. rain of 3.48 inches. This was some concern for delay in planting. October and November were dry and warm, but some snow in December helped improve moisture conditions somewhat. Snow cover remained through mid-Dec and into January and February. March was warm and dry, but precipitation picked up in April. Now May is showing to be very wet and precipitation propects are excellent. The 5.10 inches in May ranks as the 12th wettest May (thru May 28).

SNOWFALL - WINTER 2014-15 Winter snowfall has been 32.5 inches, which is about normal for winter-spring snowfall. Fall snowfall was heavy with a total of 21 inches. Dec.'14 was the heaviest with 17 inches total. Snow cover continued from mid Dec. '14 until nearly the end of Jan. '15. Cold temperatures kept snow cover for 43 days through this period. Other than the 10-inch snow on Dec. 15, '14, with 0.40 inches of precipitation, the total precipitation from snow for the winter has been light. Total "snowfall" precipitation has been only 3.38 inches, although snow event in May of 1-inch depth came as mostly rain.

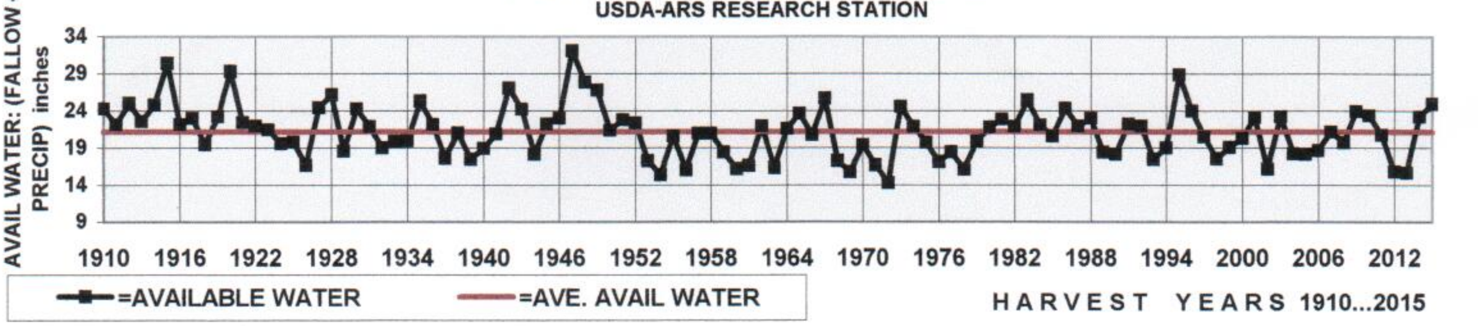
TEMPERATURES Sep.14-Jun15: The mean monthly temperatures were above average for Sep., Oct., Dec., Jan., Feb., Mar., and April. Colder months were Nov. and May. May has been substantially below average. With the warm temperatures in the winter and spring months, wheat grow was ahead of normal. The sharp freeze of May 10 & 11 may have caused considerable damage to wheat that was well ahead of normal growth patterns. Overall, the average mean temperature for the Sept.-May period ranks as the **11th warmest** of the 104-year record with complete monthly temperature data. Although the warm winter and spring has promoted growth, the late freezes on developing wheat may take a toll on yield.

AVAILABLE WATER SUPPLY:

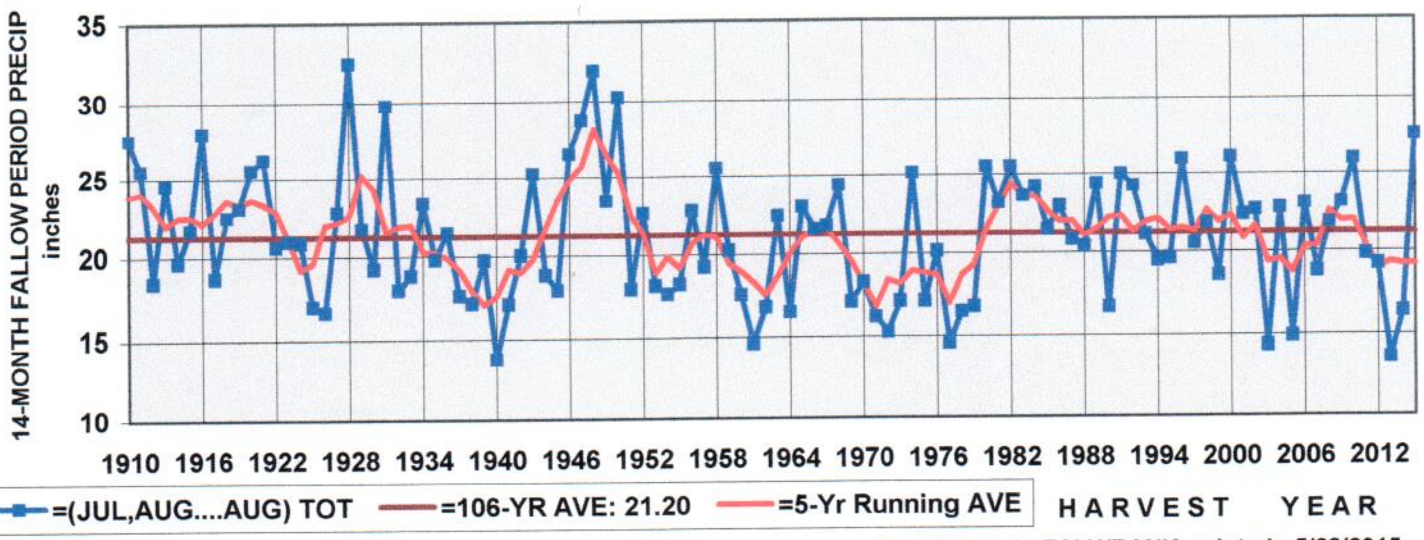
At a fallow storage efficiency of **25%**, the available water supply for the **2015-crop, *so far***, would be **19.43 inches**, which is well above the average of **16.92 inches**.
At a fallow storage efficiency of **45%**, the available water supply would be **24.95** inches, which is well above the average of **21.16 inches, not including the remainder of June**. The current wheat crop condition reflects the high fallow period precipitation, as well as the substantial growing period precipitation. At **25%** storage efficiency the seasonal available water would be 64% from growing season precipitation, and at **45%** storage efficiency growing season precipitation would be at 50% of total available. Even with a hot or dry June or pre-harvest period, it appears that the current crop will have adequate moisture to see things through to harvest. Even at **25%** storage, the 19.43 inches of water available should provide a very good yield. Weather patterns into June appear to be showing moderate temperatures with above normal precipitation, so the crop should be in excellent shape come harvest.

Fallow storage efficiency is usually a key to the success of the crop. With the near record fallow period and the substantial late-season growing period precipitation this has been somewhat masked for the 2015 crop. The range of **19.43 inches at 25% efficiency** to **24.95 inches at 45% efficiency** would appear to be adequate for a good crop.

WHEAT AVAILABLE WATER SUPPLY: @ 45% EFF
USDA-ARS RESEARCH STATION



WHEAT:14-MON FALLOW PERIOD TOTAL PRECIP
USDA-ARS RESEARCH STATION AKRON, COLO.



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WHEAT: GROWING PERIOD (SEP-JUN) PRECIP
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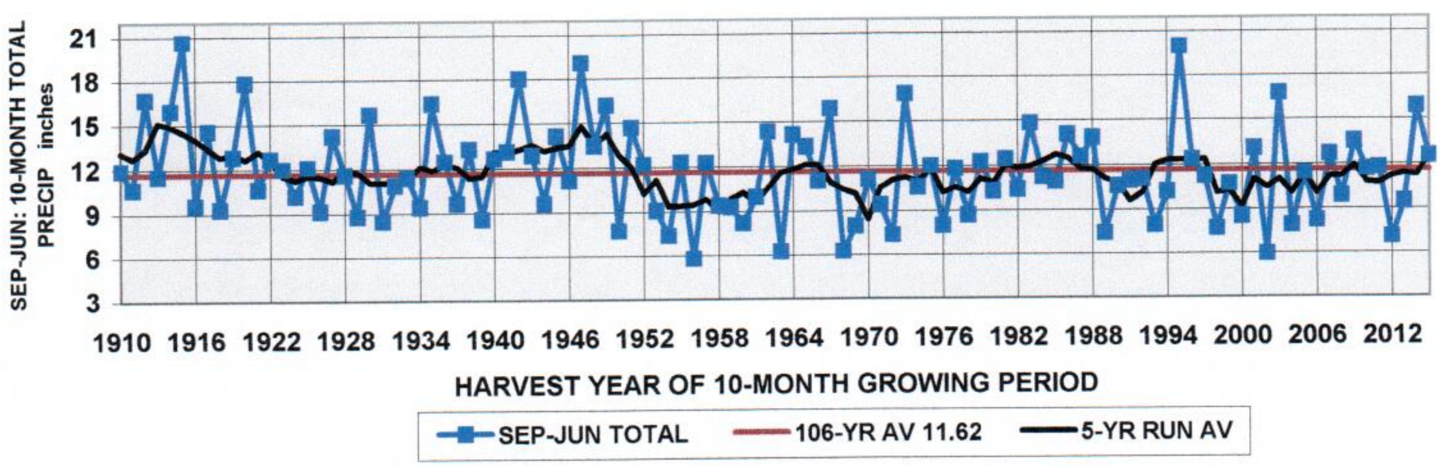

2015 updated through : MAY 28, 2015

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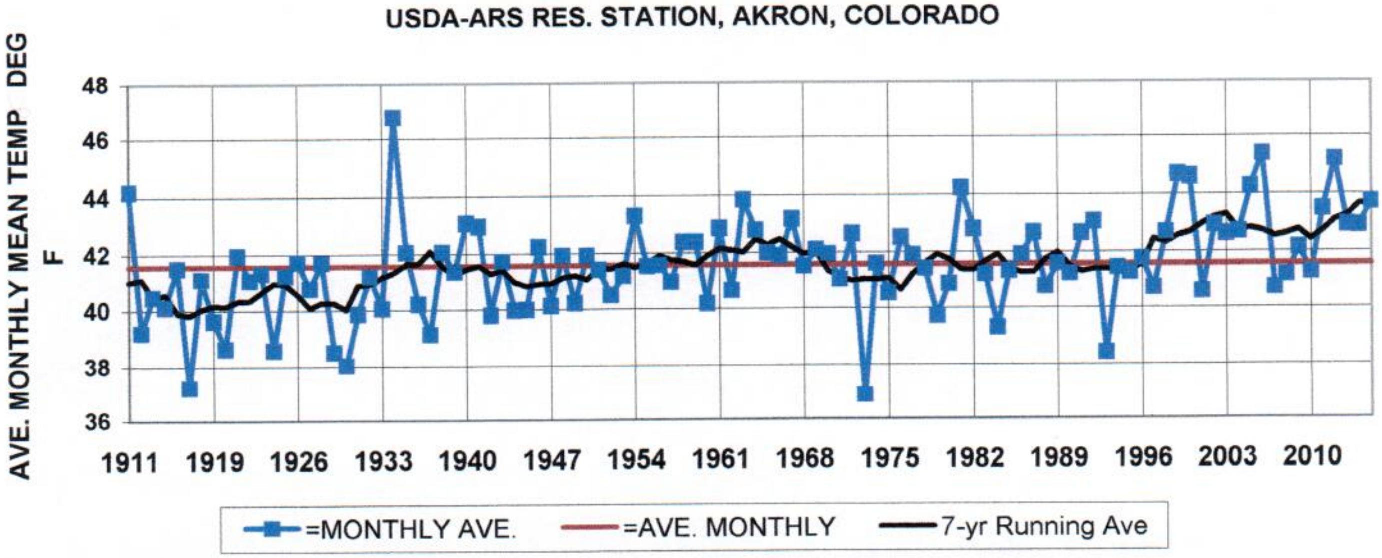
SEPT-MAY AVE. MEAN TEMP.
USDA-ARS RES. STATION, AKRON, COLORADO



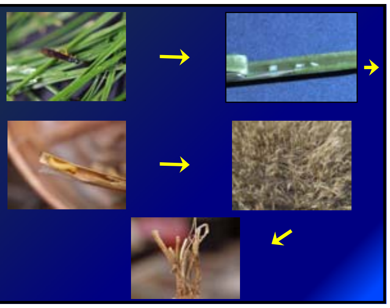
New Pests of Colorado Winter Wheat

Frank B. Peairs
Colorado State University
(970) 491-5945
Frank.Peairs@Colostate.Edu


Sipha maydis

- Found in Argentina in 2004
- Moved into all wheat-growing areas in <4 years
- Major pest
- Generally found alongside Russian wheat aphid and/or greenbug

Wheat Stem Sawfly



Stubble with overwintering larvae: stubs

Sawflies spend about 10 months per year in the stubs

Wheat stem sawfly: Yield Loss

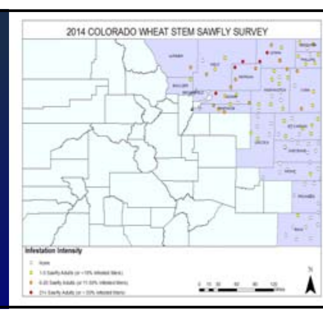
15 % without cutting damage

Loss to cutting depends on weather and success in picking up cut stems

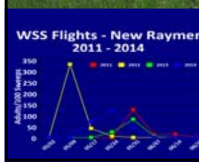
Losses of residue not quantified

Wheat stem sawfly: Current efforts

- Survey
- Plant resistance
- Understanding differences in field biology and management relative to traditionally infested areas







Use spring abundance to inform fall management decisions

Wheat stem sawfly: Management

Management has relied on resistant varieties supported by cultural practices and biological control

Wheat stem sawfly: Plant Resistance

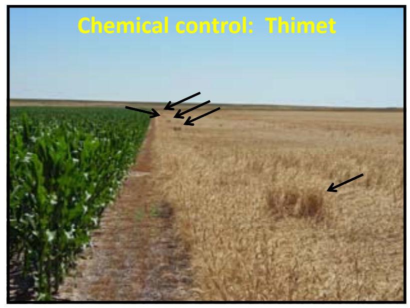
Hatcher

% Infested Stems

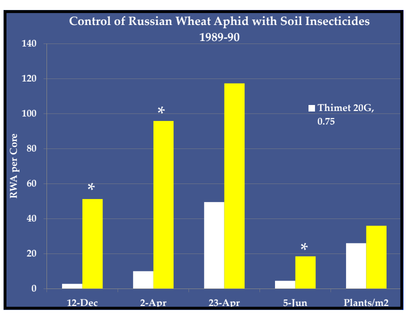
Denali	59.5
Hatcher	35.5

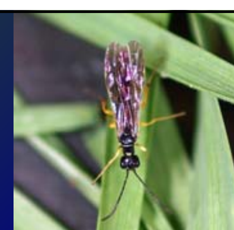
Wheat stem sawfly videos

Cultural controls



Treatment	% Infested Stems	% Lodged Stems
Thimet 20G	8.5	2.9
Warrior II, applied twice	96.0	35.2
Untreated	97.5	29.8





Questions?

Canola Production at the Central Great Plains Research Station

Field Day June 10th, 2015

Dr. M.F. Vigil, D.J. Poss, Cody Hardy, Linda Hardesty, and Paul Campbell

Introduction

The first question to consider is why canola? The US imported 1.7 billion lbs. of canola in 2014. Canola has a unique fatty acid oil profile that is healthier than other edible oils. Canola is a healthy oil with a high flash point which makes it a durable cooking oil. These facts, combined with an increase in world demand for edible oils, has farmers and researchers interested in the crop. The import volume of canola suggest a potential US canola acreage increase of several million acres.

Both winter and spring canola experiments have been conducted at the USDA-ARS Central Great Plains Research Station since 1991. These studies have researched canola establishment, water use, variety screening, N fertility needs, and potential production potential of canola for the region. Over the years varying levels of success and failure with canola have occurred. Most of the failures have been with winter-canola. Including winter-canola planted last fall (2014). Recently, with Round-up-ready (RR) spring-canola, we have had enough success to believe spring-canola is a crop option for dryland farmers in the region. That confidence prompted the establishment of a rotation study, in 2012, to evaluate the effect different preceding crops have on spring-canola's stand establishment and grain yield; as well as, the effect spring-canola has on wheat and corn following spring-canola verses wheat following fallow. In previous research, we have found the four year, no-till rotation of Wheat-Corn-Millet-fallow to be a diverse and economically competitive rotation for our region. Our question is how to best fit spring-canola into a four year rotation for farmers in our region.

We propose the comparison of two wheat based, 4 year rotations containing canola:

1.) Wheat-Corn-Millet-Canola (W-C-M-Can) (continuously cropped rotation, no summer fallow).
2.) Wheat-Canola-Corn-Fallow (W-Can-C-F) (75% cropped 25% fallow)

We expect that yields in the W-Can-C-F rotation will average 40-45 bushels wheat, 900-1000 lbs. of canola, and 50-54 bushels corn. These estimates are based on long term averages for these crops at the station in similar no-till rotations. The W-C-M-Can rotation, we expect, will average 30-35 bushel wheat, 40-45 bushel corn, 35-40 bushel millet and perhaps 500-700 lbs. of spring canola. Our objective are: 1) To determine which of these rotations (both under no-till) is better economically for producers in the region; 2) Quantify water use, N balance, and crop quality of each of the crops in the two rotations.

Methods

The two rotations will be managed using no-till practices, with herbicides controlling weeds. The plots are established on ground previously used for a comparison between stripper header management and conventional header management. Due to the sequential studies, every effort was made to match the new and old rotations, in regards to cropping history; as well as, even distribution of harvest treatment from previous study across each of the new rotations.

Our primary focus for this study is yields. Measurements such as soil water and soil N at planting and harvest are also taken. Moreover, we measure the total N of the grain samples and the oil content of the canola.

Canola Production Practices:
- **Weed Control:** All plots managed no-till primarily with glyphosate sprayed twice
- **Cultivar:** DK Spring canola Roundup Ready
- **Planting dates:** End of March-First of April
- **Seeding rates:** 6-8 lbs. (seed size determined) ~350,000 plants/acre stand goal
- **Fertilizer:** 40 lbs. N pre-plant broadcast as urea, 15 lbs. of P with the seed (11-52-0).
- **Direct seeded:** Into 10 inch cut standing stubble, double disc drill
- **Swath**: With 25% of the seeds on main raceme turn from green to brown
- **ADM**: Truck to Goodland Kansas Grain Price $7-8/bushel (50 lbs.)

Corn Production Practices:
- **Weed control:** At planting Balance, Atrazine, (dicamba ,2-4 D in crop if needed)
- **Hybrid:** Producer 5140 Non round-up Ready
- **Planting Dates:** May 15-20th
- **Seeding rate:** 12,000 plants/acre
- **Fertilizer:** 60 lbs. of N as urea pre-plant broadcast
- **Direct seeded:** Into existing standing stubble Max-emerge planter 30 inch rows
- **Harvest:** At physiological maturity ($3-$5/bushel corn

Wheat Production Practices:
- **Weed control:** Pre-plant burn-down glyphosate
- **Cultivar:** Hatcher and now Byrd ($4-$7/bushel wheat)
- **Planting dates:** September 15-October 1
- **Seeding rates:** 60 lbs./acre
- **Fertilizer:** 40 lbs. N pre-plant broadcast as urea, 15 lbs. of P with the seed (11-52-0).
- **Direct seeded:** Into existing standing stubble double disc drill

Millet Production practices:
- **Weed control:** Pre-plant burn-down glyphosate, (dicamba ,2-4 D in crop if needed)
- **Cultivar:** Hunstman ($3-$7/bushel millet)
- **Planting dates:** May 30-June 6th
- **Seeding rates:** 15-17 lbs./acre
- **Fertilizer:** 30 lbs. N pre-plant broadcast as urea, 15 lbs. of P with the seed (11-52-0).
- **Direct seeded:** Into existing standing stubble double disc drill
- **Harvest:** Swath when 2/3 of seeds on panicles are yellow, then pick up windrows when dry

Results

Crop yields were low for this study, prior to this year. Establishment in 2012, a drought year of only 8.7 inches of annual precipitation, resulted in low soil water reserves for the 2013 crop; as seen in the low beginning yields.

However, the 2013-14 crop year had more favorable precipitation (22.7 inches in 2014) resulting in better crop yields (**Table 1**). Comparing the yields, the W-Can-C-F rotation had better yields for wheat, corn in W-C-M-Can and canola than the W-C-M-Can rotation in 2014. This was also true for 2012 and 2013 except for corn. Fallow is definitely making a difference. Keep in mind, we have a millet crop with the continuous rotation and just fallow in W-Can-C-F. The 43 bushel millet crop may be enough to offset the yield advantage seen with fallow. In other words, the yield advantage seen with fallow may not offset the cost of the fallow year. We question the idea that over time the continuous rotation W-C-M-Can may be a better rotation, economically.

Table 1. Grain yields from the two rotations 2012-2014.

	W-Can-C-F			W-C-M-Can			
Year	**Wheat**	**Canola**	**Corn**	**Wheat**	**Corn**	**Millet**	**Canola**
	bu/ac	lb/ac	bu/ac	bu/ac	bu/ac	bu/ac	lb/ac
2012	32.5	0	9.1	21.6	17.2	4.7	0
2013	19.3	52	51.7	6.2	52.4	71.8	10
2014	52.4	1044	82.2	46.4	75.5	42.6	679

Table 2. Canola input cost of production.

Seed cost 6-8 lbs./acre:	**$40**
N and P Fertilizer	**$34**
Glyphosate twice	**$25**
Plant & harvest	**$33**
Truck to Crusher	**$ 5**
Total Cost	**$137**

Conclusions

In **Table 2**, we provide a rough tally of what it cost us (using custom rates) to grow spring-canola. For a farmer, the actual cost may be less if he plants, sprays, and harvests on his own; though the biggest expense will still be seed cost. However, this gives a producer a high side estimate of the cost to grow spring-canola on dryland using no-till practices. The biggest expense is seed costs. The breakeven yield for spring-canola, using $137/acre as a total cost estimate at $8/bushel canola, is 17 bushel or 850lbs/acre. Land costs, taxes and insurance are not figured into these calculations.

It is too early in the life of this experiment to make conclusions because these are four year rotations and we only have three years of data; meaning the only useable data is 2014. We plan to continue this study for at least another four years before making any conclusions. After this season (2015), both rotations would have completed just one, four-year rotation cycle, thus the expected rotation effect will just be starting. It is in the following years, 2016-2019, that provide the best data for comparing the two systems.

Nitrogen Rates and Type in Long-Term No-Tillage Cropping System

Maysoon M. Mikha, Merle F. Vigil, and Dave J. Poss

USDA-ARS, Central Great Plains Research Station, Akron, CO

In the Great Plains Region of the United States, water is one of the most limiting factors for crop production. The low precipitation, the unpredictable ambient temperature and the high evapotranspiration influences plant growth and developments. Low soil water content and drought conditions influence soil nutrient dynamics and plant nutrients uptake. Management practices that include no-till (NT) practice have proven to increase soil water storage capacity, improved nutrient dynamics, increased soil organic matter (SOM), and enhanced soil physical properties. Reduced or eliminated soil disturbance and conserved plant residue on the soil surface have a potential to reduce soil erosion. In the meantime, adapting NT practices made it possible for the producer in reducing the fallow frequency and intensifying the cropping systems in this region. With intensive cropping systems, it is recommended to include the crop with high toleration to drought conditions and low water usage in rotation. The inclusion of proso millet, corn, and grain sorghum as summer crops, in rotation with winter wheat was found to increase the producer's net return and reduce the economic losses. Manure addition as nitrogen source could improve SOM and consequently land productivity. In the meantime, the rate and type of N addition (fertilizer *vs.* manure) should be studied specifically for this region for its unique environmental condition to prevent soil nutrient loss or accumulation and to improve land sustainability.

Objectives

- Evaluate the influence of different rates and types of N (fertilizer *vs.* manure) on crop production in long-term NT cropland.

Materials and Methods

The long-term NT study was initiated in 1984 at Akron, CO with different commercial fertilizer. The rate of ammonium nitrate (NH_4NO_3) application was 0, 20, 40, 60, 80, and 160 lb N/ac in four replications. In 1995, after 11 years of the study establishment, the 160 lb N/ac study plots were changed to 120 lb N/ac due to excess amounts of N accumulation with no significant improvement in grain yield. In 2005, the 120 lb N/ac rate was changed to 80 lb N/ac. In the fall of 2006, the 80 lb N/ac fertilizer plots were changed to solid beef manure. The solid beef manure was surface spread on the plots. From 2006 to the present time the commercial fertilizer type was changed to urea [$(NH_2)_2CO$]. The amount of N added with manure was equivalent to the normal crop N needed in the rotation. In 2009 and 2012, the study was in fallow due to weather conditions and or field operational difficulties. The manure was added assuming the entire inorganic N and 25% of the organic N will be available for crop production during the first year of application. Throughout the 9 years, manure amount added was on average of 2.9 T/ac to 12 T/ac depending on the organic and inorganic manure-N content. Manure chemical properties added from 2006 to 2014 are presented in **Table 1**. Manure was added approximately one week before plant.

Table 1. Chemical characteristics of the beef manure added to the research plots from 2006 to 2014†.

Year	Moisture	PH	EC	**C:N** ratio	Total N	Inorganic N‡	Organic N	P_2O_5	K	Ca	Mg	Na	Cl	S	Zn	Fe	Mn
	%		dS m^{-1}		lb/ton												
2006-F‡‡	30.32	6.22	15.46	-----	4.6	1.74	3.0	22.0	26.0	40.6	9.4	4.4	16.8	5.6	0.40	7.24	0.34
2008-S††	26.20	8.18	15.07	24.5	20.8	2.16	18.6	15.1	17.0	46.0	8.6	2.4	3.6	4.6	0.27	9.60	0.32
2010-S	24.73	8.04	16.06	33.2	19.0	4.53	14.8	38.5	36.8	41.2	12.8	7.8	10.4	12.0	0.52	6.31	0.35
2011-S	45.42	6.71	17.30	24.3	33.2	7.51	25.6	23.4	24.6	26.8	7.2	6.6	10.2	7.2	0.28	4.18	0.19
2013-F	36.28	8.52	9.20	24.9	29.4	1.23	28.2	29.8	30.6	38.8	9.8	5.6	11.4	8.6	0.40	5.31	0.32
2014-F	10.38	7.56	11.09	13.3	46.2	5.15	41.0	48.1	47.8	4.2	15.6	11.0	16.4	13.4	0.55	7.10	0.36

† Results are expressed on wet basis (as received).

‡ Inorganic N is the sum of NH_4^+-N and NO_3^--N.

‡‡ Represents fall manure addition for forage winter triticale and winter wheat.

†† Represents spring manure addition for summer crops, corn and millet.

Table 2. Monthly ambient temperature from 2006 to 2014 and the 105 years average in Akron, CO

Months	2006	2007	2008	2010	2011	2013	2014	Average 1909-2014
	----------	----------	----------	----------	°F ----------	----------	----------	----------
January	31.4	**17.0**	20.7	29.5	25.9	28.6	**29.7**	25.9
February	35.7	**24.8**	29.4	27.9	26.1	29.4	**22.8**	30.3
March	40.2	**45.7**	38.6	39.8	41.5	35.7	**39.4**	37.2
April	46.8	**45.1**	45.0	48.6	47.2	**41.9**	**48.6**	47.0
May	56.8	**59.7**	**55.6**	**54.5**	52.8	**57.2**	**57.5**	56.9
June	**67.6**	**67.5**	**66.0**	**70.1**	**68.5**	**70.3**	**67.8**	67.4
July	**77.3**	**76.3**	**76.2**	**74.6**	**76.7**	73.2	74.1	74.3
August	**71.5**	75.3	**70.4**	**75.0**	**77.0**	73.9	71.7	72.3
September	**66.8**	65.4	**61.1**	**67.2**	63.8	**67.6**	64.7	63.2
October	**52.6**	53.4	50.8	54.7	51.7	**48.4**	55.0	50.8
November	**43.4**	40.6	41.8	37.4	38.8	**39.5**	35.8	37.4
December	**28.5**	21.4	24.6	33.4	28.8	**27.4**	28.9	28.0
Yearly Average	**51.6**	**49.6**	**48.4**	**51.1**	**49.9**	**49.4**	**49.7**	**49.2**

Table 3. Total monthly and yearly precipitation from 2006 to 2014 and the 105 years average (1909-2014) in Akron, CO

Months	2006	2007	2008	2010	2011	2013	2014	Average 1909-2014
	------------------------------ Inch ------------------------------							
January	0.02	**0.49**	0.17	0.08	0.41	0.12	**0.97**	0.32
February	0.08	**0.16**	0.64	0.53	0.19	0.38	**0.39**	0.35
March	0.62	**0.71**	0.52	0.89	0.46	1.91	**0.84**	0.83
April	0.92	**2.51**	1.14	1.51	1.31	**1.46**	**1.48**	1.66
May	1.45	**2.39**	**1.61**	**1.53**	6.55	**1.56**	**3.81**	2.93
June	**0.71**	**1.36**	**2.58**	**2.21**	**1.40**	**1.96**	**3.27**	2.46
July	**2.30**	**1.85**	**1.74**	**1.45**	**4.05**	1.59	2.28	2.67
August	**3.41**	3.74	**6.36**	**1.90**	**0.08**	2.92	4.94	2.19
September	**1.15**	0.58	**1.35**	**0.24**	1.16	**3.63**	3.48	1.25
October	**0.62**	0.17	1.33	0.64	1.09	**1.07**	0.23	0.92
November	**0.09**	0.13	0.78	0.29	0.41	**0.30**	0.29	0.54
December	**1.03**	2.42	0.34	0.30	0.24	**0.10**	0.68	0.42
Yearly Total	**12.40**	**16.51**	**18.56**	**11.57**	**17.35**	**17.00**	**22.66**	**16.54**

Crop rotations used in this study are proso millet (2006), forage winter triticale (2007), corn (2008), fallow (2009), corn (2010), proso millet (2011), fallow (2012), pea (2013), winter wheat (2013), and currently is planted to winter wheat (2014-2015). Manure (T/ac) was adjusted to be equivalent to 30 lb N/ac for winter triticale, 60 lb N/ac for proso millet and corn, and 45 lb N/ac for winter wheat. The experimental plots were organized in randomized complete design with 20 feet wide and 40 feet long plot size. Fertilizer and manure N were added in the spring before corn and millet planting and in fall of 2006, 2013, and 2014 before winter triticale and winter wheat planting. Fertilizer P was added during planting at the rate of 15 lb P_2O_5/ac to the entire field even the 0-N plots. Proso millet (hybrid "Hantsman") was seeded at 15 lb seed/ac, forage winter triticale (hybrid "NE 422T") was seeded at 60 lb seed/ac, corn (hybrid "P38#66 for 2008 and hybrid 37K11 for 2010") was seeded at 12,000 seed/ac, forage peas (hybrid "Arvika" for 2013) was seeded at 120 lb seed/ac, and winter wheat (hybrid "Brawl-CL+" for 2013 and 2014) were seeded at 60 lb seed/ac. Grain yields were evaluated at 10% moisture for proso millet, 15% for corn, and 12.5% for wheat. Forage winter triticale and forage pea biomass were calculated on an oven dry weight basis.

Results and Discussion

Ambient air temperature from 2006 to 2014 with the 105 years average temperature is presented in **Table 2**. The ambient temperature fluctuations throughout the crop growing seasons compared with the 109 years average were observed. The synchronization between the ambient temperature and the precipitation **(Table 3)** with critical crop growth stage could reveal the influence of the weather pattern on crop development and crop production in each given year. Throughout the reported study period (2006-2014), the precipitation being highlighted is in correspondence to the crop growing season for individual crops in a given year **(Table 3)**. In 2008 total precipitation was 2.0 inches higher than the 109 years normal precipitation. The extra 2 inches of precipitation could be helpful if they were distributed throughout the year. Although there were 4.2 inches of additional precipitation than normal that occurred in the month of August, the extra precipitation did not show a positive response to the corn yield **(Figure 1)** compared with 2010. Therefore, the synchronization between the crop critical growth stage and the precipitation is highly important.

The different rates of commercial fertilizer did not influence millet grain yield in 2006 **(Figure 1)**. Manure was added for the first time in fall of the 2006 after harvesting millet and before planting winter triticale. The amount of manure added was equivalent to 30 lb N/ac which represented the required amount of N for triticale production in this study location. Different N rates and sources did not statistically influence triticale forage production **(Figure 2)**. Manure addition increased forage triticale production by approximately 346 lb/ac compared with commercial fertilizer added at 40 lb N/ac. Almost the same pattern was observed with corn yield in 2008 **(Figure 1)**, there were no differences in corn yield observed due to N rates or sources. The addition of manure increased corn yield by approximately 9 bu/ac compared with commercial fertilizer at the equivalent N rate of 60 lb N/ac.

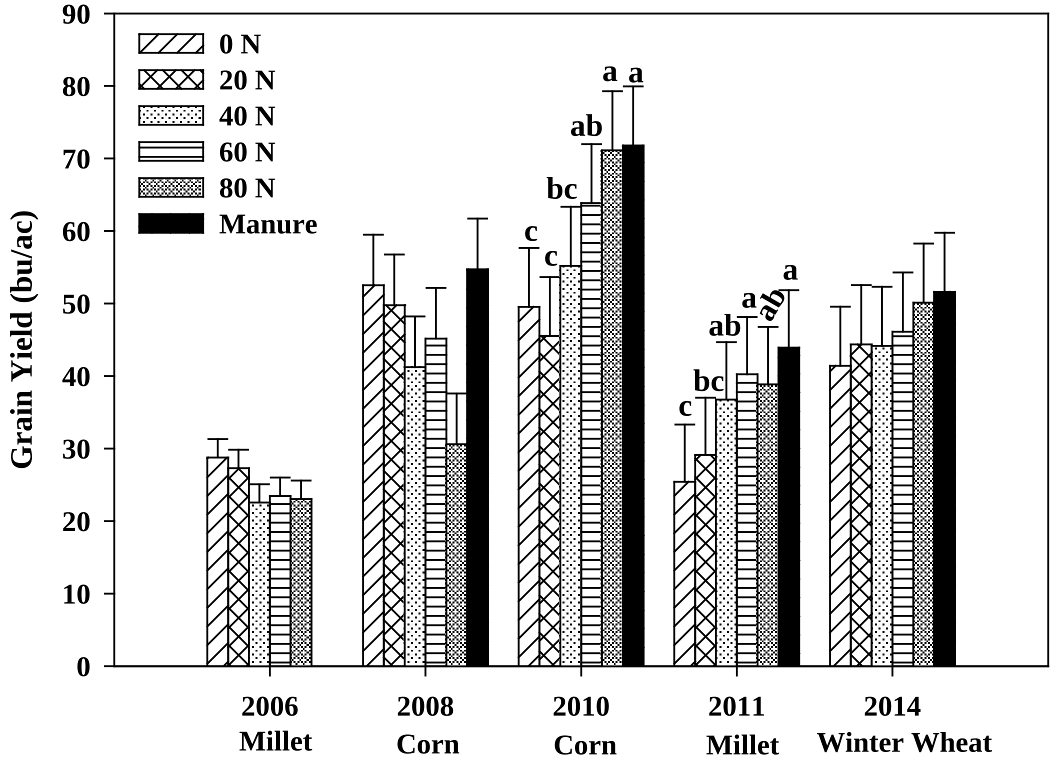


Figure 1. Crop grain yields (bu/ac) at different N rates and types in no-till cropping system from 2006-2014 growing season.

In 2010 and 2011, grain yields were partially influenced by different N rates of the commercial fertilizer **(Figure 1)**. Corn yield increased by 8 bu/ac and millet yield increased by 4 bu/ac with manure addition at the equivalent N rate of commercial fertilizer of 60 lb N/ac. Forage pea production in 2013 was influenced by low precipitation throughout the growing season, planting in April to harvest in June, **(Table 3).** Total precipitation throughout the peas growing season was approximately 5 inches compared with the average of 105 years precipitation of approximately 7 inches. Nitrogen rates and sources did not have an influence on winter wheat grain yield production in 2014 **(Figure 1)**. Nevertheless, manure addition increased wheat yield by 6 bu/ac compared with commercial fertilizer at N rate equivalent to 40 lb N/ac. The precipitation of 6.6 inches during the months of August and September of 2013 compared with the 105 years average of 3.4 inches helped to recharge soil water that was necessary for wheat establishments **(Table 3)**. Over all, total precipitation throughout the wheat growing season (September 2013 to June 2014) was approximately 15.9 inches which was higher by 4.2 inches than the 105 years average, 11.7 inches, **(Table 3)**. The high precipitation throughout the wheat growing season could contribute to the lack of differences in wheat yield among the N rates and types. The higher wheat production associated with manure could be related to improving soil micronutrients other than N and P that was added as commercial fertilizer.

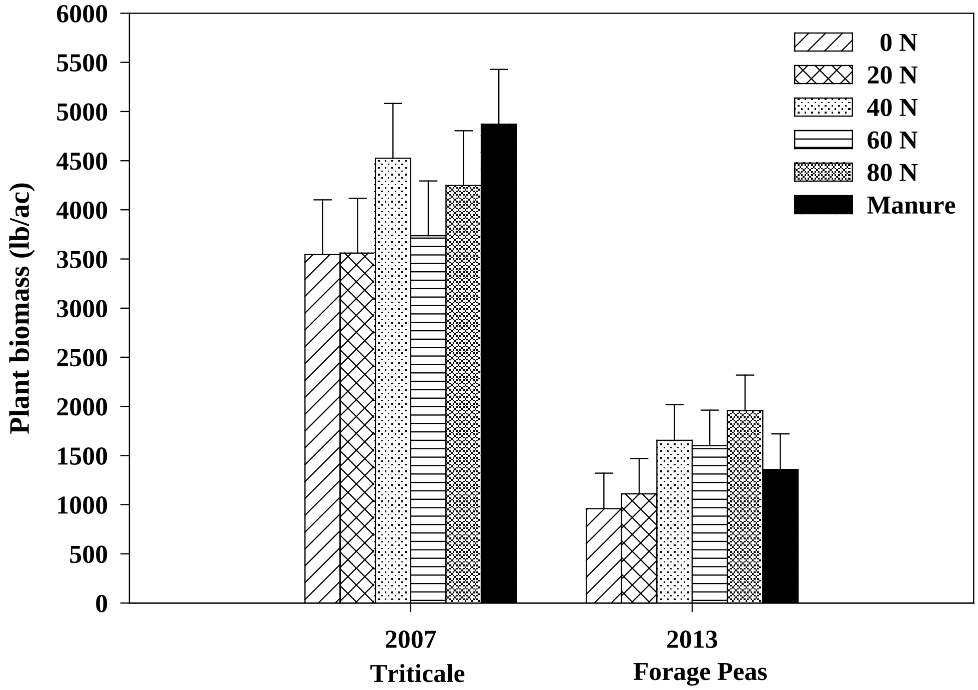


Figure 2. Winter triticale and forage pea biomass production (lb/ac) at different N rates and type in no-till cropping system.

Conclusions

- Throughout the study period from 2006 to 2014, grain yield or forage biomass production was not statically influenced by commercial fertilizer except in 2010 and 2011 where high N rates showed some improvement in crop production
- Manure addition as organic amendment, partially improved grain yield and triticale production compared to fertilizer.
- The lack of yield improvement could mainly be related to low precipitation (compared to the 105 years average) throughout the growing season of different crop in rotation. Low precipitation could also influence nutrient dynamics and consequently reduce yields.
- The partial improvement in crop production associated with manure was probably related to improving some aspects of soil quality and soil micronutrients that supported a slight improvement in yield production in comparison to commercial fertilizer.
- Higher fertilizer rates than the normal rate required for different crop production did not improve yields in this study site due to low precipitation.
- During the year where the precipitation was higher than average, nitrogen rates and sources did not have a significant influence on crop yields.
- The micronutrients and macronutrients added with manure could have a positive influence on crop production throughout the last six years of manure addition relative to commercial fertilizer (urea) that contained only N.

Future Researches

- The influence of N rates, types and the weather pattern on the productivity will be further evaluated in the coming years.
- Changes in soil chemical, physical, and biological properties in this study site will be evaluated in the future.

- Continue with the long-term Remediation/Restoration study using manure for several more years to evaluate the improvement in soil quality and plant productivity.

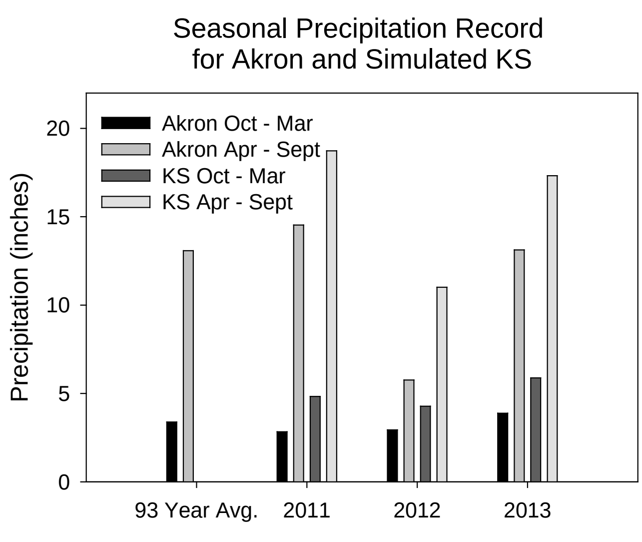
Wheat Yields in Rotations with Sunflower

Joe Benjamin

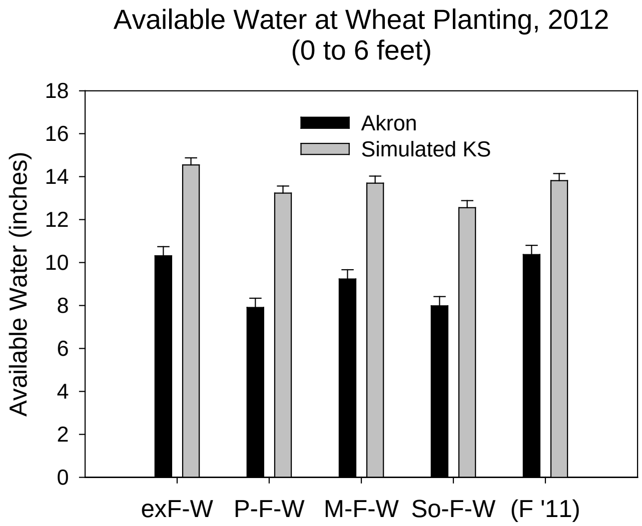
Sunflowers are a well-adapted crop for the central Great Plains. However, sunflower extract water to lower water contents and extract water to deeper depths than many other crops. Often a long fallow period is recommended before planting the next crop in rotation to allow for soil water recharge. In a semi-arid climate, full water recharge often does not occur prior to the planting subsequent crops, leading to dry soil conditions and low yields for crops following sunflower.

Water storage efficiency (the ratio of change in soil water storage to the rainfall that occurs) is often low for rainfall occurring during the summer. High evaporation demand caused by high temperatures and low relative humidity causes much of the rainfall that falls during the summer to evaporate and not be stored in the soil. Water storage efficiency is much greater for precipitation that occurs during the cooler fall, winter, and spring months. We hypothesize that growing a crop to use summer precipitation may benefit total crop production while not affecting water storage prior to planting winter wheat.

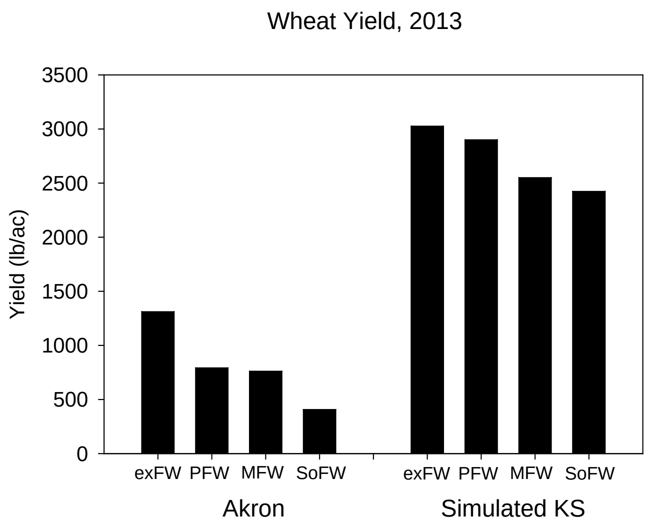
A study was established in 2010 to investigate possible rotations with sunflower suitable for the semi-arid Great Plains. The rotations included sunflower – extended fallow – winter wheat (Sun-exF-W), sunflower – proso millet – fallow – winter wheat (Sun-M-F-W), sunflower – field pea – fallow – winter wheat (Sun-P-F-W), and sunflower – grain sorghum – fallow – winter wheat (Sun-So-F-W) rotations. The experiment was conducted under natural Akron weather conditions. Supplemental water was added to part of the experiment to simulate the rainfall typical of central Kansas. Water was added at the beginning of each month to account for the difference in long-term average rainfall between Akron and Hays, KS. Water contents were measured with a neutron probe to a depth of six feet. Water storage during the fallow period and water storage efficiency was determined for each rotation.



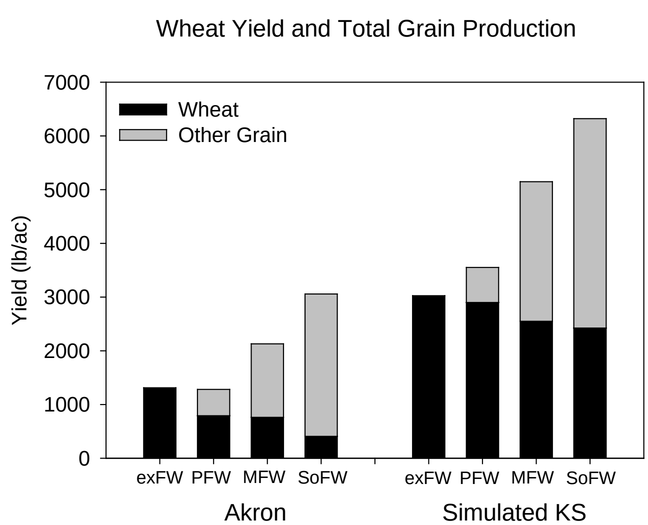
Total precipitation averages about 16 inches per year at Akron, CO and about 22 inches per year at Hays, KS. Most of the precipitation comes during the summer months. Winter precipitation (Oct – Mar) each year at Akron was about 3 inches, which is similar to the long-term average. Summer precipitation (Apr – Sept) was greatest in 2011 (14.5 inches) and lowest in 2012 (5.8 inches).



With natural Akron precipitation, available water (AW) at wheat planting in 2012 was 1 to 2 inches less when a summer crop was included in the rotation compared with extended fallow. There was little difference in AW at planting between the fall of 2011 and the fall of 2012, indicating that the extended fallow was ineffective for storing more soil water. AW at wheat planting in the plots with simulated central KS conditions was 3 to 5 inches greater than under Akron conditions. The plots containing a summer crop also had 1 to 2 inches less AW at planting than the plots with extended fallow.



Wheat yields were poor (< 22 bu/ac) under Akron weather conditions. The 1 to 2 inches lower AW at planting reduced wheat yields by 9 bu/ac (PFW) to 15 bu/ac (SoFW) compared with extended fallow. Greater AW at wheat planting and greater in-season precipitation under simulated KS conditions resulted in 1700 to 2000 lb/ac greater wheat yields compared with natural Akron conditions. The 1 to 2 inches less available water at planting resulted in 2 bu/ac (PFW) to 10 bu/ac (SoFW) reduction in wheat yield.



Even though wheat yields were reduced due to water use by summer crops, total grain production was increased by including a summer crop such as millet or grain sorghum. Productivity was most enhanced in the simulated KS conditions when grain sorghum was included in the rotation. Even though there was a 20% reduction in wheat yield, total productivity doubled.

Impacts of Residue Removal and Tillage on Water Infiltration

Joel P. Schneekloth, David Nielsen and Francisco Calderon

Problem: Continual removal of residue can have significant impacts on soil properties as well as the potential productivity without the additional input of nutrients to offset those removed in the residue. Water infiltration is an important aspect of soil health in regions that are limited on moisture and can have intense precipitation events. In dryland and limited irrigation system, precipitation utilization is an important factor to consider.

Approach: A study began in 2014 at Akron, CO looking at the impact of residue removal and tillage upon the soil characteristics important to crop production as well as crop production and the economics. Two tillage treatments, No-Till (NT) and Tilled (T) were incorporated with residue removal (NR) and no residue removal (R).

The Cornell Infiltrometer was utilized to measure 1) time to first runoff, 2) total water infiltrated and 3) steady state infiltration. Changes in infiltration over time were also measured to determine the impacts of residue management and tillage.

Results:

Residue Cover Residue from the 2 treatments with residue removal were done in early April of 2014. Tillage plots were tilled immediately after residue removal. Tillage was done with a disc. Plots with the residue removed were tilled 2 times while the plots with the residue remaining were tilled 3 times. Residue cover for the T/NR was approximately 13% while the NT/R plots had 89% cover. Both NT/NR and T/R plots had approximately 55% residue cover. Both NT and the T/R plots were within conservation compliance which mandates a minimum of 30% cover.

Impacts to Infiltration

One of the benefits of residue and reduced tillage has been the resulting increase in infiltration by previous research. Increasing tillage destroys macro and micro pore structure which reduced infiltration of water. Maintaining or increasing infiltration is important for irrigation sprinkler package design to reduce runoff potential without increasing system pressure to increase the wetted diameter and reduce the maximum application rate. In the fall of 2014, a Cornell Infiltrometer was used to measure infiltration patterns of the treatments.

Differences were observed in the pattern of measured infiltration by residue management. Where residue was not removed, infiltration was greater than that of when residue was removed no matter what tillage system was utilized. The major changes in infiltration rates were within the first 300 seconds when water was applied. Positive impacts when residue remained in the field were observed for the 3 major factors of infiltration. The time for measurement of first runoff (**Table 1**) was doubled when residue remained in the field and was left on the surface or incorporated. When residue was removed, average time to observe runoff was approximately 110 seconds but when residue was not removed the average time to observe runoff was 235 seconds.

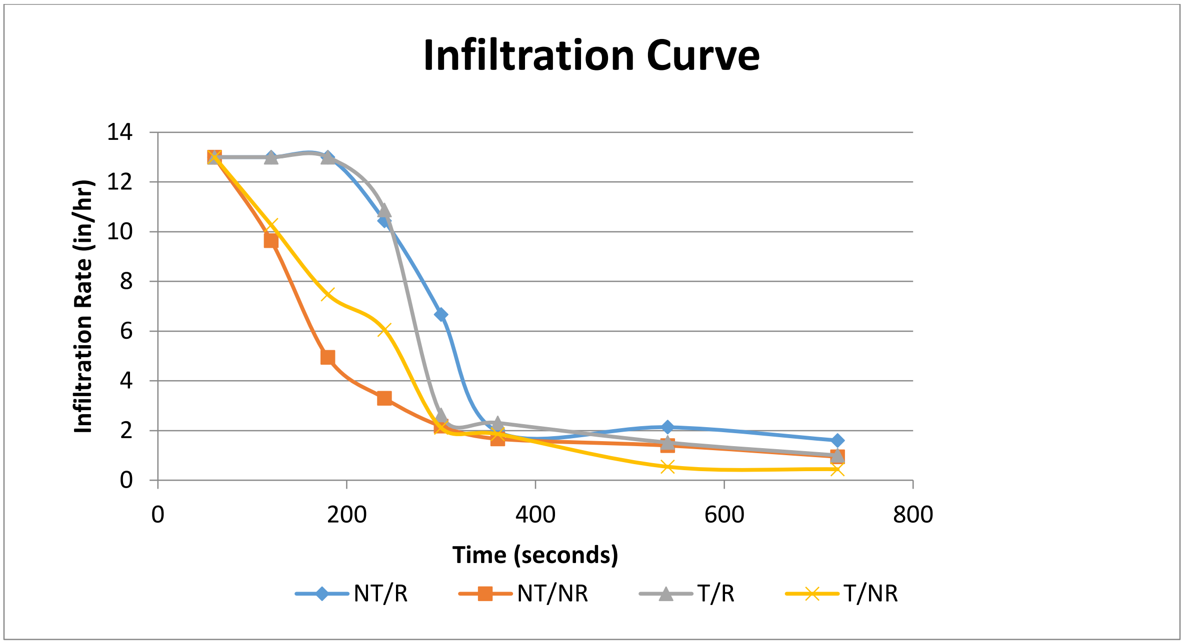
The total water infiltrated in 30 minutes was approximately 0.50 inches greater when residue was not harvested (1.36 inches vs 0.81 inches). Intensive precipitation events can better utilized when larger amounts of residue remain on the surface of the soil allowing for reduced irrigation needs. Irrigation system management and design can be minimized by increased infiltration rates which can either reduce energy inputs required for increased pressure for larger wetted diameters to compensate for reduced infiltration rates and runoff potential. With greater infiltration as a result of not harvesting residue, irrigation depths can be increased without the potential of runoff which is important on land with greater slopes.

Changes in the infiltration patterns is shown in **Figure 1**. When residue remained in the field, infiltration remained higher when compared to when residue was removed.

Table 1. Infiltration parameters for residue and tillage management.

Tillage	Residue Mgt.	Time to first runoff Seconds	Steady State Infiltration in hr^{-1}	Total Infitration Inches
No-till	Residue	253	1.04	1.36
	No Res	111	0.61	0.81
Tilled	Residue	217	1.21	1.35
	No Res	112	0.69	0.81

Figure 1. Changes to infiltration curve due to residue management and tillage.



Update about organic Wheat research at the CGPRS.

Francisco J. Calderón and Merle F. Vigil

PROBLEM: Feedlot composts are a valuable resource in the Central Great Plains due to the large beef industry. Manure compost can improve soil structure, while supplying necessary nutrients to dryland crops. Ag management practices can increase soil organic matter, but this may take many years to take effect. In contrast, compost deployment, will have immediate results by adding organic matter directly to the soil. Feedlot compost is especially rich in P, supplying near 15 Lbs per ton for reasonable quality compost. Nitrogen in compost is considered slow-release, and can amount to ~35 lbs per ton. More aged composts tend to be slower to release their N. For this reason, when using compost as a N fertilizer, it should be taken in account that P might become excessive before the N demands of the crop are met. A balance needs to be attained between the N and P in the compost to achieve good crop yields, while avoiding excessive amounts of P and salts. Soil type, crop demands, climate, and compost quality all determine how much of the compost C and nutrients cycle into the soil and plants. We are carrying out a multi-year field experiment to study the long term soil C, N and P dynamics in organic compost-based wheat and forage production. This project at the CGPRS examines the effect of three compost levels on yields and soil quality in wheat fallow, as well as a forage winter crop of triticale+Austrian winter pea.

APPROACH: The land was in grass prior to the experiment. The area was plowed and un-fertilized winter wheat was grown in the 2008-09 season in order to absorb the flush of N expected after plowing sod. The land was then fallowed until establishment of the experiment plots in 2010. The plots have since been managed without synthetic fertilizers or herbicides. Starting in the fall of 2010, three compost treatments have been applied every other year to the field: a nothing-added control, a 1x treatment according to expected N demand (10.3 American t/a), and a 5x rate (48.9 t/a). The 1x treatment was based on an expected 40 lbs/acre available N for first season, which assumes that approximately 11% of the compost N is released. The experiment has four replicates, and was designed so that the crop and fallow phases of both rotations are present every year. Weed control has been done by sweep tillage as needed, and the wheat has been harvested with a stripper header. The forage has been harvested by mowing and baling at pea flowering time. Measurements have included: Grain yields, biomass at harvest, pre-plant soil moisture, grain and biomass C and N content, soil C, N and P content, and soil quality according to infrared spectroscopy. At present, almost four full rotations have been completed: The 2010-2011, 2011-12, the 2013-14, and part of the 2015 season. The experiment was interrupted during the 2012-13 season due to extreme drought, triticale was uniformly planted on all research plots for soil conservation purposes, so no what grain yield data is available for that year.

RESULTS: Compost has been very effective at increasing the extractable soil P, with the 5X treatment reaching to more than 9 times higher extractable P than the control or the grass buffer (**Table 1**). Crop rotation did not affect soil P. However, this effect was observed in the 1X and 5X treatments. The P content of the 1X is optimum to high, whereas the P in the 5X has reached beyond very high, with the associated potential for erosion losses and low likelihood for a response to further P fertilization. With these results, we will not be applying more compost to the 5X treatments in the coming years, which will mean that the 5X will have to rely on existing soil N and residual compost N. These results show that compost is a rich source of P which can significantly and rapidly increase the P supply to crops.

Responses in soil C and N have been lower than the soil P (**Table 2**). The 1X compost treatment has had no discernible effect on total soil N or C at this stage of the experiment.

The 5X treatment has increased soil N by ~26%, and a similar increase was observed for soil C. Soil % N and % C in the 2-4' depths ranged from 0.04-0.12 and 0.87-1.43 respectively, with no significant compost or rotation effect (not shown). However, the increases in C in the 5X are not trivial, given that C increases in the adjacent Alternative Crop Rotations (ACR), which relies on crop residue returns to accumulate C, have taken much longer to achieve similar results. The soil N contents are high, more than twice than those of the ACR, indicating that there might still be a good amount of N available for future crops via N mineralization.

Our plan to manage the experiment as an organic farming system has constrained us to use tillage rather than herbicides for weed control, with the disadvantage of losing ~2 in/yr of soil moisture compared to no-till. Preplant moisture has ranged from 5.7- 10.2 for the top 4 ft in the different treatments and years, and it has been strongly influenced by the amount of precipitation and water recharge during the different fallow years.

Table 1 Soil extractable P in the organic plots (0-1' depth). Samples taken in October 2014.

	lbs-P/acre	ppm
0	18.9	5.1
1	58.1	15.8
5	173.5	47.3
Grass buffer	15.9	4.3

Table 2. Soil C and N content (0-1' depth) in the organic plots. Samples taken in October 2014 after manure application.

Compost rate	Crop	N%	C%
0x	T/P-F	0.19	1.52
0x	W-F	0.15	1.26
1x	T/P-F	0.17	1.41
1x	W-F	0.18	1.44
5x	T/P-F	0.24	1.90
5x	W-F	0.24	1.94
0x	Grass buffer	0.15	1.40

Table 3. Precipitation in inches during the wheat growing season, 2011-14.

Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	sum
2010-11									
0.6	0.3	0.3	0.4	0.2	0.5	1.3	6.6	1.4	11.6
2011-12									
1.1	0.4	0.2	0.1	1.5	0.1	1.7	0.7	0.1	6.0
2012-13									
0.6	0.2	0.4	0.1	0.4	1.9	1.5	1.6	2.0	8.7
2013-14									
1.1	0.3	0.1	1.0	0.4	0.8	1.5	3.8	3.3	12.3
2014-15									
0.2	0.3	0.7	0.3	0.4	0.4	1.9	*4.9*	-	-
106 y average									
0.9	0.5	0.4	0.3	0.3	0.8	1.6	2.9	2.4	10.3

Plant biomass yields have fluctuated due to yearly precipitation variation with high yields in the 2011 season relative to 2012 and 2014 (**Tables 3 and 4**). The 2011-12 season was extremely dry and warm resulting in depressed yields. Biomass yields were also low in 2013-14 despite average season precipitation.

In 2011, the 5X compost treatment achieved high wheat and triticale biomass, but not high wheat grain yields (**Tables 4 and 5**), suggesting soil moisture depletion before the reproductive stage.

Peas overall competed poorly with the triticale in the mixture, seeding rates were 50:50, but pea biomass was always well below the triticale biomass. Negative pea biomass response to the 5X in 2011 indicates that compost has a negative effect on pea and favors triticale (not shown). Compost applied on 2011 had a protracted positive effect on the triticale and pea 2012 biomass, but not so on the wheat (**Table 4**). Wheat and triticale+pea biomass responded to the 5X in 2013-14, but no response was observed for the 1X treatment. Biomass yields in the 0x treatment declined throughout the years with the utilization of the natural leftover fertility of the plowed grass soils.

Table 4. Biomass for 2011, 2012, and 2014 seasons, in lbs/a.

Compost	Wheat	Trit.+ pea
2011:		
0x	8808	8501
1x	8706	8296
5x	9652	9879
2012:		
0x	4192	4124
1x	3867	4318
5x	3513	5158
2014:		
0x	3876	3935
1x	3534	3631
5x	4454	4489

Wheat grain yields were better in 2011 than 2012 due to the 2011-12 season drought conditions (**Table 3 and 5**). Compost had a negative effect on wheat yields in 2011 and 2012, due to a decline in the harvest index with compost application. This trend was reversed in 2013-14, with a positive response in grain yields and harvest index to the 5X treatment.

Table 5. Wheat grain yields in bu/a (dry).

Compost	2011	2012	2014
0x	35.9	20.8	20.0
1x	30.7	14.5	15.3
5x	29.8	16.5	26.3

The 2014 wheat grain harvest responded to the 5X compost treatment but not to the 1X. The yields of the organically managed wheat were generally lower than in conventionally managed WF (NT) plots adjacent to the organic experiment yielded 42-69 bu/a (dry) in 2011, 30-41 in 2012, and 38-67 in 2014.

Low test weights are associated with less starch and more protein in the grain. In 2011, 5X compost slightly reduced test weight relative to 0X: From 50 to 49 in 2011, from 60 to 59 in 2012, and from 57 to 55 in 2014. The low test weights could have been caused by the earlier water depletion with higher vegetative growth with the 5X. Compared to adjacent conventionally grown wheat, test weights were low in 2011, but similar in 2012. WF (NT) in the ACR had test weights of in 56-60 2011, and 58-61 in 2012.

So far the 2015 season looks to be producing good biomass in both grain and forage rotations, but the cool and very wet April and May seem to have brought good conditions for wheat leaf rust.

FUTURE PLANS: Our plan is to extend this experiment for several more years to see how the different compost rates will affect soil organic matter soil phosphorus, and crop yields. It will be interesting to see how long we can sustain productivity in the 0x treatment. The plots will eventually be used to examine how the widely different P contents are distributed into plant available P as well to P forms that are unavailable for roots. We will also study how the molecular structure of the soil organic matter differs between the 3 compost treatments, the crop rotations, and the grass buffers. The ultimate question will be how resistant to decomposition is the soil C in the different treatments, and how available is the soil organic N for future crops.

Cover Crop Biomass Production

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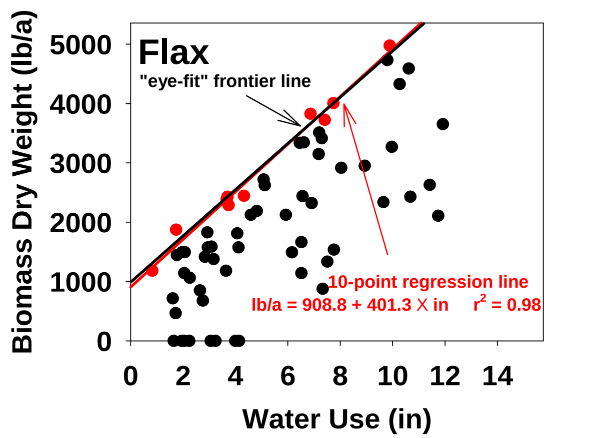
Some Important Previous Results

- Cover crops use water, even when grown in mixtures
- Cover crops generally reduce the yield of the following crop
- Cover crop mixtures don't promote greater soil microbiological activity than single species



Regression Slope and Intercept for Cover Crop Biomass vs Water Use

Species	Slope	Intercept	R^2	Biomass Productivity
	(lb/a/in)	(lb/a)		($g\ g^{-1}$)
Rapeseed	383.9	1007	0.96	0.43
Flax	401.3	909	0.98	0.46
Pea	414.6	1435	0.86	0.65
Mixture	533.6	888	0.93	--
Oat	618.3	357	0.96	0.70

Biomass Productivity is grams of seed produced per gram of photosynthate [Sinclair and de Wit (1975)]

Estimated Average Biomass Yield