Publication No. PHREC 14-30

Nebraska Lincoln EXTENSION

High Plains Ag Lab

Update of Research Conducted in 2013

February 13, 2014

University of Nebraska
High Plains Agricultural Lab
Sidney, Nebraska

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High Plains Ag. Lab. Advisory Committee Annual Meeting
February 13, 2014 at 9:00 AM to 12:30 PM
Community Center, 627 Toledo Street St., Sidney, NE

AGENDA

Administrative Updates

9:00 AM: Welcome by Keith Rexroth, HPAL Advisory Board Chair

9:05 AM: HPAL general update by Dr. Gary Hergert, Interim Director, Panhandle Research and Extension Center

- Faculty position update
- HPAL BQMS (New Biotech facility) update
- New Building update

HPAL Research Updates

9:30 AM: HPAL operations, *Tom Nightingale, Farm Manger, HPAL*

9:45 AM: 2013 weather updates *Dr. Wayne Shawcroft*

10:05 AM: Cover crops and water use, *Dr. David Nielsen*

10:20 AM: Alternative crops and wheat, *Dr. Dipak Santra*

10:35 AM: Hail, curl mite and wheat virus infestation, *Dr. Jeff Bradshaw (for Dr. Gary Hein)*

10:50 AM: Perennial grass production, *Dr. Gary Hergert*

11:05 AM: Livestock, range and forage, *Dr. Karla Jenkins*

Wrap-up session

11:20 AM: General Discussion by All

- What is being done right?
- What is NOT being done right?
- What should be done differently?
- 2014 HPAL Field day June or Aug along with New Building dedication)
- Quarterly Newsletter
- Other business as necessary

11:50 AM: HPAL Advisory Board Business Meeting

Noon: Adjourn

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ANNUAL REPORT

2013

HIGH PLAINS AGRICULTURAL LABORATORY

UNIVERSITY OF NEBRASKA

PANHANDLE RESEARCH AND EXTENSION CENTER

LOCATION: Six miles Northwest of Sidney, Nebraska

This report was prepared by the High Plains staff,

and Manager, Tom Nightingale

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2013-2014

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PERSONNEL AT HPAL
2013

Employee	Title	Period Worked
Tom Nightingale	Manager	Jan 75-Dec 13
Paul McMillen	Farm Foreman	Mar 83-Dec 13
Rob Higgins	Crops Tech	May 91-Dec 13
Vernon Florke	Crops Tech	May 07-Dec 13
Jeremy Reimers	Summer Work	May 13-Aug 13
Jennifer Blanke	Summer Work	May 12-Aug 13
Justin McMechan	Post Doc. Student	May 12-Aug 13

PROFESSIONAL STAFF OF THE PANHANDLE RESEARCH AND EXTENSION CENTER WHO CONDUCTED EXPERIMENTAL TRIALS OR WERE INVOLVED AT THE HIGH PLAINS AGRICULTURAL LABORATORY

STAFF MEMBER	TITLE
Dr. Linda Boeckner	Director, Panhandle Res & Ext Center
Dr. Gary Hergert	Prof of Agronomy/Horticulture, Interim Director
Dr. Jeff Bradshaw	Asst Prof of Entomology
Dr. Dipak Santra	Asst Prof of Agronomy/Horticulture
Dr. Alexander Pavlista	Prof of Agronomy/Horticulture
Dr. Karla Jenkins	Asst Prof of Animal Science
Karen Deboer	Extension Educator
Aaron Berger	Extension Educator
Karen Schultz	Business Manager, PREC
Harrison Boateng	System Support Specialist

PROFESSIONAL STAFF WITH THE UNIVERSITY OF NEBRASKA WHO CONDUCTED EXPERIMENTAL TRIALS OR WERE INVOLVED AT THE HIGH PLAINS AGRICULTURAL LABORATORY

STAFF MEMBER	TITLE
Dr. Stephen Baenziger	Prof of Agronomy/Horticulture
Dr. Gary Hein	Prof of Entomology & Director of Plant Health Program
Dr. Robert Graybosch	USDA-ARS
Dr. Stephen Wegulo	Assoc Prof of Plant Pathology
Dr. Stevan Knezevic	Prof of Agronomy/Horticulture
Dr. Teshome Regassa	Asst Ext Educator, Agronomy/Horticulture

PROFESSIONAL STAFF OUTSIDE THE UNIVERSTIY OF NEBRASKA WHO HAD COOPERATIVE STUDIES WITH REGULAR STAFF MEMBERS

NAME	ORGANIZATION
Dr. Drew Lyon	Washington State University
Dr. Gary Peterson	Colorado State University
Dr. Merle Vigil	USDA-ARS, Akron, CO
Dr. David Nielsen	USDA-ARS, Akron, CO
Dr. Maysoon Mikha	USDA-ARS, Akron, CO
Dr. Francisco Calderon	USDA-ARS, Akron, CO
Dr. Joseph Benjamin	USDA-ARS, Akron, CO

RESEARCH TRIALS CONDUCTED DURING 2013

WHEAT

TRIAL	STAFF	DESCRIPTION
Wheat nursery	Baenziger Graybosch Santra	Exp. Varieties in comparison with established varieties
Wheat quality	Baenziger Lan Xu	Milling and baking quality of varieties
Long term tillage studies	Hergert Higgins	Comparisons of plow, subtill, and no-till
White wheat nursery	Baenziger Graybosch	Exp. white wheats
Winter wheat variety trial	Santra Regassa Florke	Varieties & exp. lines
2-Gene Clearfield winter wheat	Hergert Higgins	Evaluation of seed treatment combined with fungicide treatments
Clearfield winter wheat	Hergert Higgins	Evaluation of weed control and tolerance of 2-gene CL winter wheat for feral rye control
FMC Fallow Trial	Hergert	Combinations of Authority & Spartan Charge for kochia & Broadleaf weed control in fallow
Hail Simulation Study	Hein McMechan Higgins	Window of risk establishment during heading stages of wheat
Over-summering ecology Of the wheat-curl mite	Hein McMechan	Establishing risks for alternative over-summer hosts for wheat curl Mites

WHEAT

Impact of rainfall on wheat curl mite population	Hein McMechan	Simulated rainfall at various stages of headed wheat
Planting date & variety selection For management of the wheat	Hein McMechan Higgins	Evaluation of early and late planting of commercial varieties of winter wheat
Weed survey of winter Wheat stubble	Hein McMechan	Weed survey of grassy weeds in tri-state area

FORAGES

TRIAL	STAFF	DESCRIPTION
Winter triticale	Santra Baenziger	Winter triticale varieties
Forage production	Jenkins Hergert Lyon Berger Stone Higgins	Comparison of sorghum-sudan, oats, & foxtail millet after winter wheat harvest, under limited irrigation

SUNFLOWERS

Sunflower varieties, oils	Santra Florke	Dryland and irrigated sunflower varieties
Sunflower varieties, confections	Santra Florke	Irrigated confection varieties

RESEARCH TRIALS CONDUCTED DURING 2013

BIODIESEL CROPS

Biofuel	Hergert Margheim	Comparison of grass varieties for biofuel production
Winter Canola	Santra Hergert Higgins	Evaluation of no-till, minimum till, and stale seedbeds for winter canola production

SPECIALITY CROPS

TRIAL	STAFF	DESCRIPTION
Fenugreek variety trial	Santra Florke	Fenugreek varieties for yield Oil content. Dryland & irrigated
Fenugreek herbicides	Santra Higgins	Herbicide screening, Pre & Post
Cover crop water use	Lyon Nielsen Hergert Higgins	Evaluation of cover crop water use and impact on following winter wheat crop

MILLET

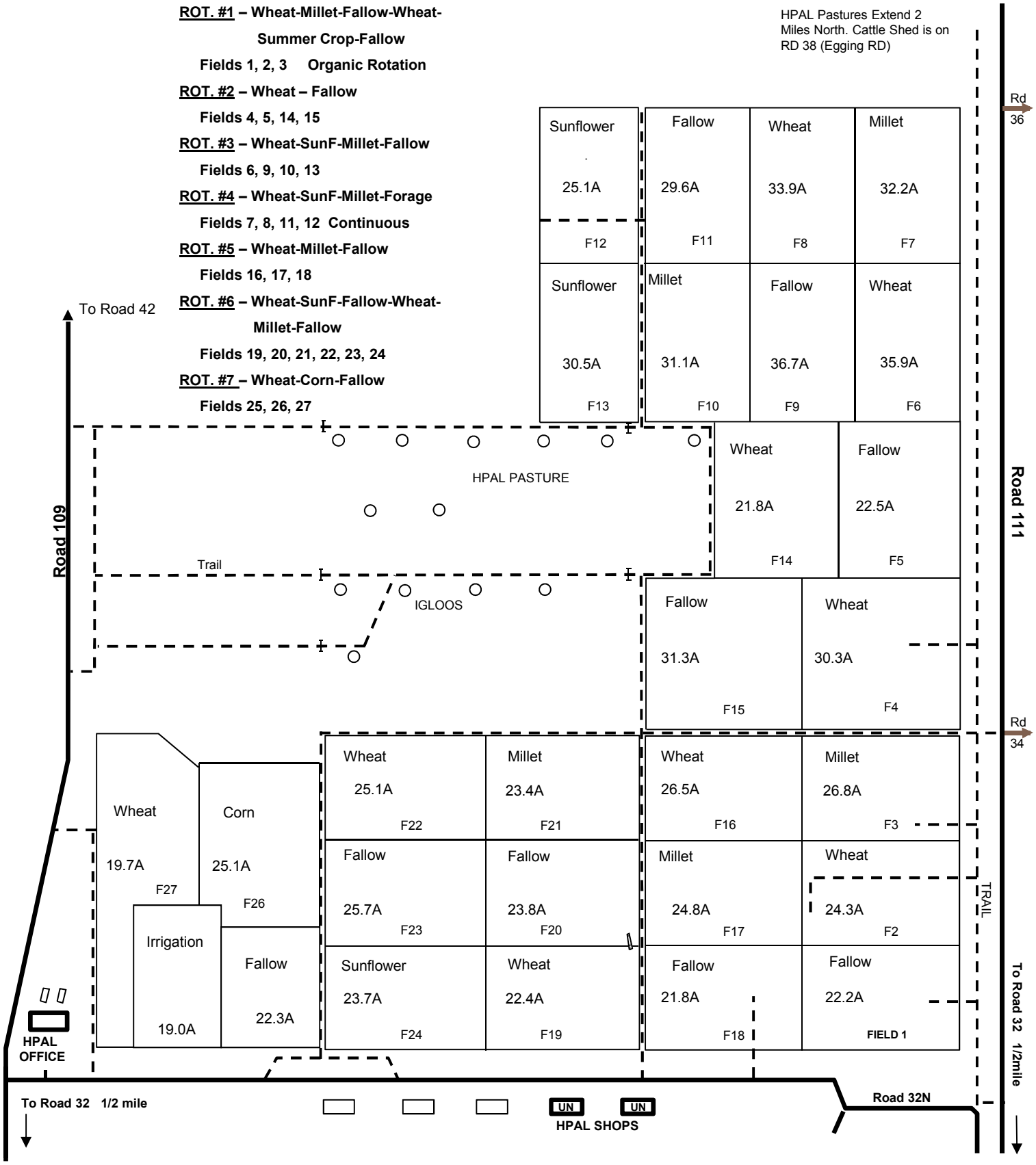
Proso millet variety trial	Santra Florke	Dryland & irrigated varieties
Proso millet breeding	Santra Florke	White proso experimental lines F3 Head rows

2013 HPAL

UNIVERSITY of NEBRASKA
HIGH PLAINS AG LAB

NORTH ↑

ROT. #1 – Wheat-Millet-Fallow-Wheat-Summer Crop-Fallow
Fields 1, 2, 3 Organic Rotation
ROT. #2 – Wheat – Fallow
Fields 4, 5, 14, 15
ROT. #3 – Wheat-SunF-Millet-Fallow
Fields 6, 9, 10, 13
ROT. #4 – Wheat-SunF-Millet-Forage
Fields 7, 8, 11, 12 Continuous
ROT. #5 – Wheat-Millet-Fallow
Fields 16, 17, 18
ROT. #6 – Wheat-SunF-Fallow-Wheat-Millet-Fallow
Fields 19, 20, 21, 22, 23, 24
ROT. #7 – Wheat-Corn-Fallow
Fields 25, 26, 27

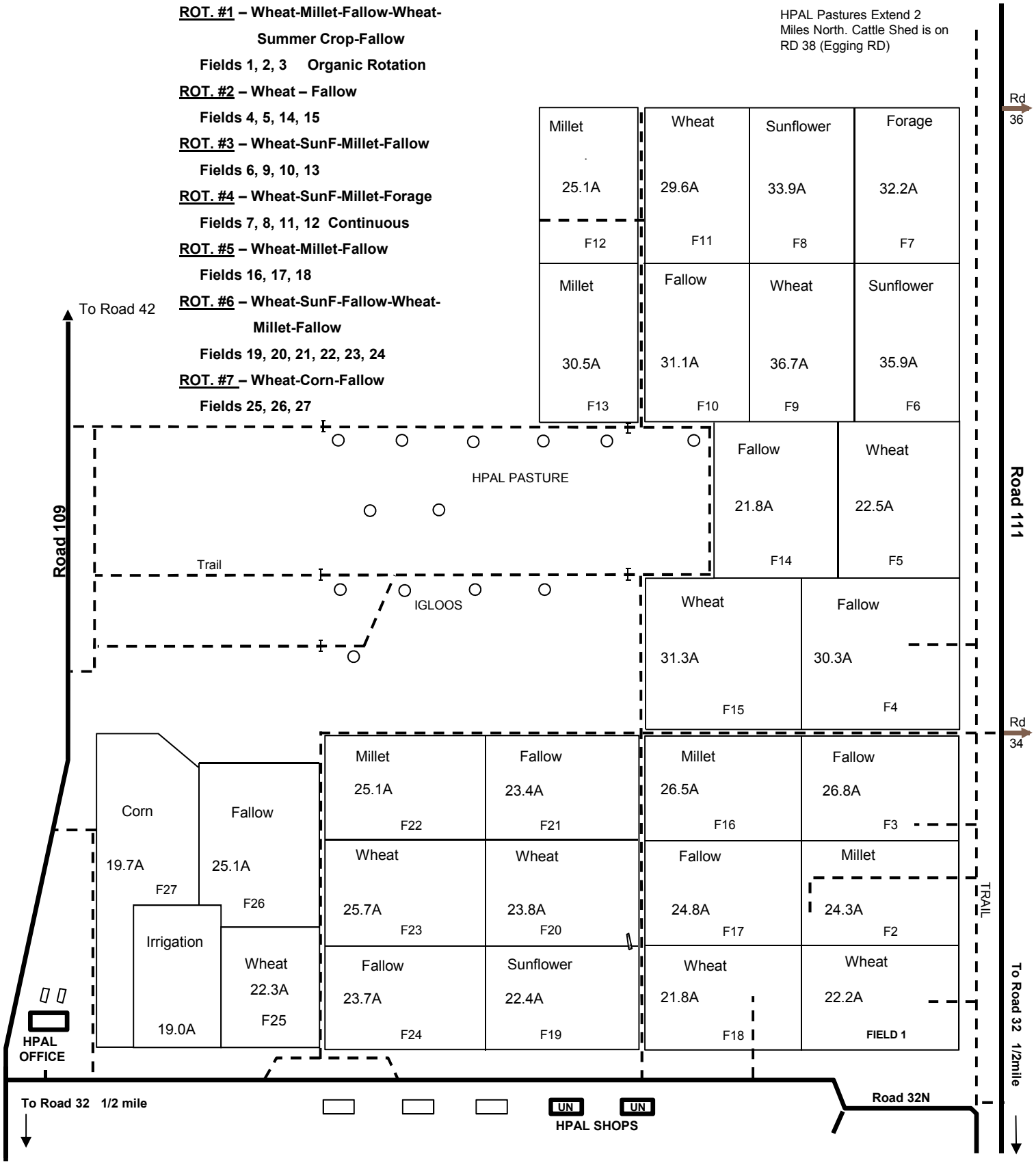


2014 HPAL

UNIVERSITY of NEBRASKA
HIGH PLAINS AG LAB

NORTH ↑

ROT. #1 – Wheat-Millet-Fallow-Wheat-Summer Crop-Fallow
Fields 1, 2, 3 Organic Rotation
ROT. #2 – Wheat – Fallow
Fields 4, 5, 14, 15
ROT. #3 – Wheat-SunF-Millet-Fallow
Fields 6, 9, 10, 13
ROT. #4 – Wheat-SunF-Millet-Forage
Fields 7, 8, 11, 12 Continuous
ROT. #5 – Wheat-Millet-Fallow
Fields 16, 17, 18
ROT. #6 – Wheat-SunF-Fallow-Wheat-Millet-Fallow
Fields 19, 20, 21, 22, 23, 24
ROT. #7 – Wheat-Corn-Fallow
Fields 25, 26, 27



YIELD SUMMARIES
2011, 2012, 2013

ROTATION

	2011	2012	2013
R#1	**WHEAT – MILLET – FALLOW – WHEAT – SUNFLOWER – FALLOW; ORGANIC**		
F1	Wheat-38.9bu/a	SunF-473lb/a	Fallow
F2	SunF-0.0lb/a	Fallow	Wheat-40.6 bu/a
F3	Fallow	Wheat-50.6bu/a	Millet-0 bu/a-hail
R#2	**WHEAT – FALLOW**		
F4	Wheat-22.2bu/	Fallow	Wheat-44.3 bu/a
F5	Fallow	Wheat-50.8bu/a	Fallow
F14	Wheat-19.9bu/a	Fallow	Wheat-47.4 bu/a
F15	Fallow	Wheat-45.1bu/a	Fallow
R#3	**WHEAT – SUNFLOWER – MILLET – FALLOW**		
F6	Millet-28.5bu/a	Fallow	Wheat-39.2 bu/a
F9	SunF-1360lb/a	Millet-2.6bu/a	Fallow
F10	Wheat-35.4bu/a	SunF-843lb/a	Millet-10.7 bu/a
F13	Fallow	Wheat-46.3bu/a	SunF-710 lb/a
R#4	**WHEAT – SUNFLOWER – MILLET – FORAGE**		
F7	Wheat-24.7bu/a	SunF-843lb/a	Millet-0 bu/a-hail
F8	Millet-23.8bu/a	Forage-Grazed	Wheat-37.5 bu/a
F11	SunF-1478lb/a	Millet-2.6bu/a	Fallow
F12	Forage-Grazed	Wheat-41.7bu/a	SunF-710 lb/a

YIELD SUMMARIES (con't)

ROTATION

	2011	2012	2013
R#5	**WHEAT – MILLET – FALLOW**		
F16	Fallow	Wheat-44.6bu/a	Wheat-23.8 bu/a
F17	Fallow	Wheat-50.3bu/a	Millet-10.7 bu/a
F18	Wheat-20.9bu/a	Millet-42.1bu/aFallow	
R#6	**WHEAT – SUNFLOWER – FALLOW – WHEAT – MILLET – FALLOW**		
F19	Millet-18.3bu/a	Fallow	Wheat-41.9 bu/a
F20	Wheat-39bu/a	Millet-42.9bu/a	Fallow
F21	Fallow	Wheat-43.6bu/a	Millet-10.7 bu/a
F22	SunF-1135lb/a	Fallow	Wheat-30.3 bu/a
F23	Wheat-33.7bu/a	SunF-843lb/a	Fallow
F24	Fallow	Wheat-43.8bu/a	SunF-969 lb/a
R#7	**WHEAT – CORN – FALLOW**		
F25	Wheat-30.3bu/a	Corn-41.3bu/a	Fallow
F26	Fallow	Wheat-53.5bu/a	Corn-79.3 bu/a
F27	Corn-65.3bu/a	Fallow	Wheat-41.2 bu/a

CROP

	2011	2012	2013
Wheat	29.9bu/a	47.0bu/a	34.7 bu/a
Millet	23.9bu/a	22.6bu/a	5.8 bu/a-hail
Sunflower	1341.2lb/a	843lb/a	783.3 lb/a
Corn	65.3bu/a	41.3bu/a	79.3 bu/a

HIGH PLAINS AG LAB WEATHER DATA
OCTOBER 1, 2012 – SEPTEMBER 30, 2013

Month	Precipitation		Avg. Max. Temp.		Avg. Min. Temp.	
	2013	Normal	2013	Normal	2013	Normal
October	1.02	0.90	62.2	64.3	32.7	33.7
November	0.11	0.46	57.7	49.8	26.5	21.9
December	0.25	0.31	42.8	40.9	15.3	14.7
January	0.17	0.28	42.6	39.6	12.1	12.4
February	0.64	0.34	41.7	43.3	15.5	16.2
March	0.32	0.91	51.9	50.1	22.2	22.4
April	2.27	1.62	54.4	59.7	27.3	31.1
May	3.19	2.88	70.9	69.5	42.3	41.6
June	2.93	3.15	83.9	79.8	52.0	51.2
July	3.95	2.61	86.3	87.9	58.3	57.4
August	1.35	1.95	88.3	85.9	58.0	55.5
September	8.44	1.39	80.1	76.8	51.6	45.4
Year	24.64	16.80	63.6	62.3	34.5	33.6

Normal = 66 year average

2013 CROP ROTATION #1
3 Year Stacked – Organic
Fields 1, 2, 3
Wheat, Millet, Fallow, Wheat, Sunflower, Fallow

Operations

Field 1 – 22.2 acres – Fallow - Previous crop, Sunflowers

June 14	Spread 9 ton/a manure
June 17	Disc
July 9	Chisel with dead-rod
July 23	Chisel with dead-rod
Aug 13	Chisel with dead-rod
Sept 3	Chisel with dead-rod
Sept 18	Finish mulcher
Sept 19	Seed 45 lb/a Pronghorn wheat
Oct 3	Finish mulcher
Oct 9	Re-seed Pronghorn wheat

Field 2 – 24.3 acres – Wheat – Previous crop, Fallow

July 22	Harvest wheat – yield, 40.6 bu/a
Aug 19	Undercut

Field 3 – 26.8 acres – Millet – Previous crop, Wheat

May 24	Disc
June 13	Finish mulcher
June 14	Finish mulcher
June 17	Seed 15 lb/a millet
Aug 6	Hail, millet gone
Aug 20	Undercut

2013 CROP ROTATION #2
2 Year
Fields 4, 5, 14, 15
Wheat, Fallow

Operations

Field 4 – 30.3 acres – Wheat – Previous crop, Fallow

July 18	Harvest wheat – yield 44.3 bu/a
Aug 2	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

Field 5 – 22.5 acres – Fallow – Previous crop, Wheat

May 9	24 oz/a RT3
June 28	22 oz/a Powermax + 8 oz/a LV6
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 29	22 oz/a Powermax = 10 oz/a LV6
Sept 30	Seed 50 lb/a Settler CL wheat

Field 14 – 21.8 acres – Wheat – Previous crop, Fallow

July 18	Harvest wheat – Yield 47.4 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Oct 10	24 oz/a Buccaneer Plus

Field 15 – 31.3 acres – Fallow – Previous crop, Wheat

May 9	24 oz/a RT3
June 28	22 oz/a Powermax + 8 oz/a LV6
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 29	22 oz/a Powermax + 10 oz/a LV6
Sept 30	Seed 50 lb/a Settler CL wheat

2013 CROP ROTATION #3
4 Year
Fields 6, 9, 10, 13
Wheat, Sunflower, Millet, Fallow

Operations

Field 6 – 35.9 acres – Wheat – Previous crop, Fallow

May 26	40 lb/a nitrogen
July 18	Harvest wheat – Yield 39.2 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 21	22 oz/a Powermax + 8 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

Field 9 – 36.7 acres – Fallow – Previous crop, Millet

May 13	24 oz/a RT3
May 27	40 lb/a nitrogen
June 14	20 oz/a Powermax + 1.5 oz/a Sharpen
July 5	Undercut
Aug 12	Chisel with dead-rod
Sept 6	Chisel with dead-rod
Sept 18	Finish mulcher
Sept 19	Seed 45 lb/a Pronghorn wheat
Oct 2	Finish mulcher
Oct 8	Re-seed Pronghorn

Field 10 – 31.1 acres – Millet – Previous crop, Sunflowers

May 13	24 oz/a RT3
May 26	40 lb/a nitrogen
June 11	Seeded 15 lb/a millet
July 4	8 oz/a 2-4 amine + 3 oz/a dicamba
Aug 6	Hail
Oct 3	Harvest millet – Yield 10.7 bu/a

Field 13 – 30.5 acres – Sunflowers – Previous crop, Wheat

May 9	24 oz/a RT3
May 25	40 lb/a nitrogen
June 4	Seed 16,000/a Croplan 306 NS oil sunflowers
June 7	2 pt/a Prowl H2O + 2.5 oz/a Spartan Charge + 20 oz/a RT3
June 21	4 oz/a Mustang Max, air applied for cutworms
Aug 7	11.75 oz/a Stallion, air applied for head moth
Oct 17	Harvest sunflowers – Yield 710 lb/a

2013 CROP ROTATION #4
4 Year Continuous
Fields 7, 8, 11, 12
Wheat, Sunflower, Millet, Forage

Operations

Field 7 – 32.2 acres – Millet – Previous crop, Sunflowers

May 13	24 oz/a RT3
May 26	40 lb/a nitrogen
June 11	Seed 15 lb/a millet
June 12	20 oz/a RT3 + 1.5 oz/a Sharpen
July 4	8 oz/a 2-4D amine + 3 oz/a dicamba
Aug 6	Hail, millet gone
Aug 21	22 oz/a Powermax + 8 oz/a LV6

Field 8 – 33.9 acres – Wheat – Previous crop, Forage

May 25	40 lb/a nitrogen
July 18	Harvest wheat – Yield 37.5 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 21	22 oz/a Powermax + 8 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

Field 11 – 29.6 acres – Fallow – Previous crop, Millet

May 26	40 lb/a nitrogen
June 3	20 oz/a RT3 + 8 oz/a LV6
June 14	20 oz/a Powermax + 1.5 oz/a Sharpen
July 5	Undercut
Aug 11	Chisel with dead-rod
Sept 6	Chisel with dead-rod
Sept 18	Finish mulcher
Sept 20	Seed 45 lb/a Pronghorn wheat
Oct 2	Finish mulcher
Oct 8	Re-seed Pronghorn

Field 12 – 25.1 acres – Sunflowers – Previous crop, Wheat

May 9	24 oz/a RT3
May 25	40 lb/a nitrogen
June 5	Seed 16,000/a Croplan 306 NS oil sunflowers
June 7	2 pt/a Prowl H2O + 2.5 oz/a Spartan Charge + 20 oz/a RT3
June 21	4 oz/a Mustang Max, air applied for cutworms
Aug 7	11.75 oz/a Stallion, air applied for head moth
Oct 17	Harvest sunflowers – Yield, 710 lb/a

2013 CROP ROTATION #5
3 Year
Fields 16, 17, 18
Wheat, Millet, Fallow

Operations

Field 16 – 26.5 acres – Wheat – Previous crop, Wheat

May 27	40 lb/a nitrogen
July 21	Harvest wheat – Yield 23.8 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

Field 17 – 24.8 acres – Millet – Previous crop, Wheat

May 8	24 oz/a RT3
May 27	40 lb/a nitrogen
June 12	Seed 15 lb/a millet
June 14	20 oz/a Powermax + 1.5 oz/a Sharpen
July 3	8 oz/a 2-4D amine + 3 oz/a dicamba
Oct 2	Harvest millet – Yield 10.7 bu/a

Field 18 – 21.8 acres – Fallow – Previous crop, Millet

May 9	24 oz/a RT3
June 13	20 oz/a RT3 + 1.5 oz/a Sharpen
July 12	22 oz/a Powermax + 8 oz/a LV6
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Sept 9	Seed 50 lb/a Pronghorn wheat

2013 CROP ROTATION #6
6 Year
Fields 19, 20, 21, 22, 23, 24
Wheat, Sunflower, Fallow, Wheat, Millet, Fallow

Operations

Field 19 – 22.4 acres – Wheat – previous crop, Fallow

May 25	40 lb/a nitrogen
July 20	Harvest wheat – Yield, 41.9 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

Field 20 – 23.8 acres – Fallow – Previous crop, Millet

May 9	24 oz/a RT3
May 27	40 lb/a nitrogen
June 28	22 oz/a Powermax + 8 oz/a LV6
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Sept 9	Seed 50 lb/a Pronghorn wheat

Field 21 – 23.4 acres – Millet – Previous crop, Wheat

May 9	24 oz/a RT3
May 26	40 lb/a nitrogen
June 12	Seed 15 lb/a millet
June 13	20 oz/a RT3 + 1.5 oz/a Sharpen
July 3	8 oz/a 2-4D amine + 3 oz/a dicamba
Oct 2	Harvest millet – Yield, 10.7 bu/a

Field 22 – 25.1 acres – Wheat – Previous crop, Fallow

May 26	40 lb/a nitrogen
July 21	Harvest wheat – Yield, 30.3 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

2013 CROP ROTATION #6 cont.

Field 23 – 25.7 acres – Fallow – Previous crop, Sunflowers

May 27	40 lb/a nitrogen
May 31	20 oz/a RT3 + 8 oz/a LV6
June 28	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Sept 26	24 oz/a Buccaneer Plus
Sept 30	Seed 50 lb/a Settler CL wheat

Field 24 – 23.7 acres – Sunflowers – Previous crop, Wheat

May 8	24 oz/a RT3
May 25	40 lb/a nitrogen
June 6	Seed 16,000/a Croplan 306 NS oil sunflowers
June 7	2 pt/a Prowl H2O + 2.5 oz/a Spartan Charge + 20 oz/a RT3
June 21	4 oz/a Mustang Max, air applied for cutworms
July 2	2 qt/a Powermax
July 3	Replant 16,000/a Croplan 306NS oil sunflowers
Aug 7	11.75 oz/a Stallion, air applied for head moth
Nov 24	Harvest sunflowers – Yield, 969 lb/a

2013 CROP ROTATION #7
3 Year
Fields 25, 26, 27
Wheat, Corn, Fallow

Operations

Field 25 – 22.3 acres – Fallow – Previous crop, Corn

May 26	40 lb/a nitrogen
May 31	20 oz/a RT3 + 8 oz/a LV6
June 28	22 oz/a Powermax + 8 oz/a LV6
Aug 2	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 29	22 oz/a Powermax + 10 oz/a LV6
Sept 21	Seed 50 lb/a Settler CL wheat

Field 26 – 25.1 acres – Corn – Previous crop, Wheat

May 8	24 oz/a RT3
May 11	Seed 14,000/a Croplan C-3337 RR corn
May 13	1 lb/a atrazine
May 24	60 lb/a nitrogen
June 12	20 oz/a RT3
Oct 15	Harvest corn – Yield, 79.3 bu/a

Field 27 – 19.7 acres – Wheat – Previous crop, Fallow

July 22	Harvest wheat – Yield 41.2 bu/a
July 31	22 oz/a Powermax + 8 oz/a LV6 + 3 oz/a dicamba
Aug 22	22 oz/a Powermax + 10 oz/a LV6
Oct 7	24 oz/a Buccaneer Plus

2013 WEATHER SUMMARY
SIDNEY, NEBRASKA AREA

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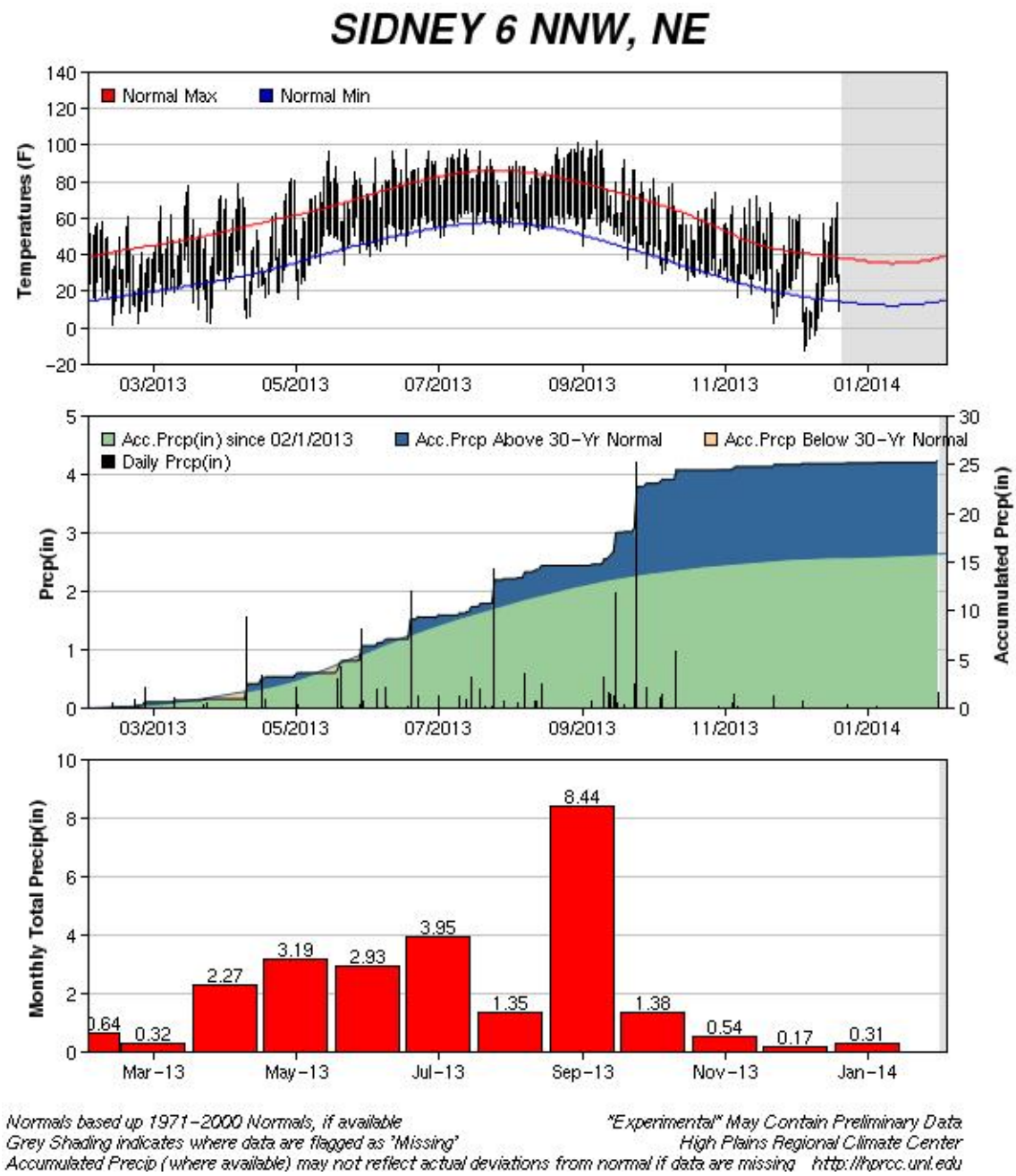
After a near epic year in 2012, that saw many new high temperature records and low precipitation records, the hopes and anticipation for 2013 would be that there would be a return to more "normal" conditions. As the 2013 weather year developed it did, in fact, return to more normalcy than the extremes in 2012. For example, the USDA-ARS Research Station Records at Akron, Colorado showed that only **34 new records** were set in 2013. Of these 22 were new high temperature records and 12 were new low temperature records, and their were no new precipitation records set during the year. This is in contrast to the 2012-weather year where **70 new records** were set, which included **63 high temperature** records, 5 **low temperature** records, and **2 low precipitation** records. So the 2013-weather summary will not be an emphasis on the **"HOTTEST AND DRIEST"** as in 2012.

There were, however, some significant events in the 2013-weather year that, although may not have been records, did have considerable impact on everyday life and activities as well as crop production conditions. These significant events were 1) **the cold early spring temperatures of March and April**, 2) **the near record setting heat of late August and early September**, and 3**) the major flooding events of mid to late September**. Most other months had basically the more normal variations from cool to hot, and dry to wet without major extremes.

The contrast between **2012** and **2013-weather** years was highlighted in the Akron data with a comparison of the annual mean temperatures for the years. The **Annual Mean Temperature** of **2012** was **53.36 ^{o}F,** which broke the previous 102-year record of **52.64 ^{o}F** set in 1934. The **2013 Annual Mean Temperature** was **49.43 ^{o}F**, which ranks as the **32nd warmest year of the 102-complete year record.**

Similarly, the annual totals for precipitation from Akron showed an **8.71 inch total in 2012,** the driest year on record. The **Annual Precipitation Total in 2013 was 17.00 inches**, which ranked as the **46th wettest** in the 106-year Akron record or just above the 106-year average of **16.38 inches.** The Akron data is used here to show an overall 2013 trend. With the reasonable proximity of the Sidney area and the Akron area, the same general trends in Sidney would be expected.

The following charts show data from the Sidney area. Specifically two sites are used as reported from the High Plains Regional Climate Center, namely the **Sidney 6 miles North,** and **Sidney 3 miles South (MUNI)** recording stations.

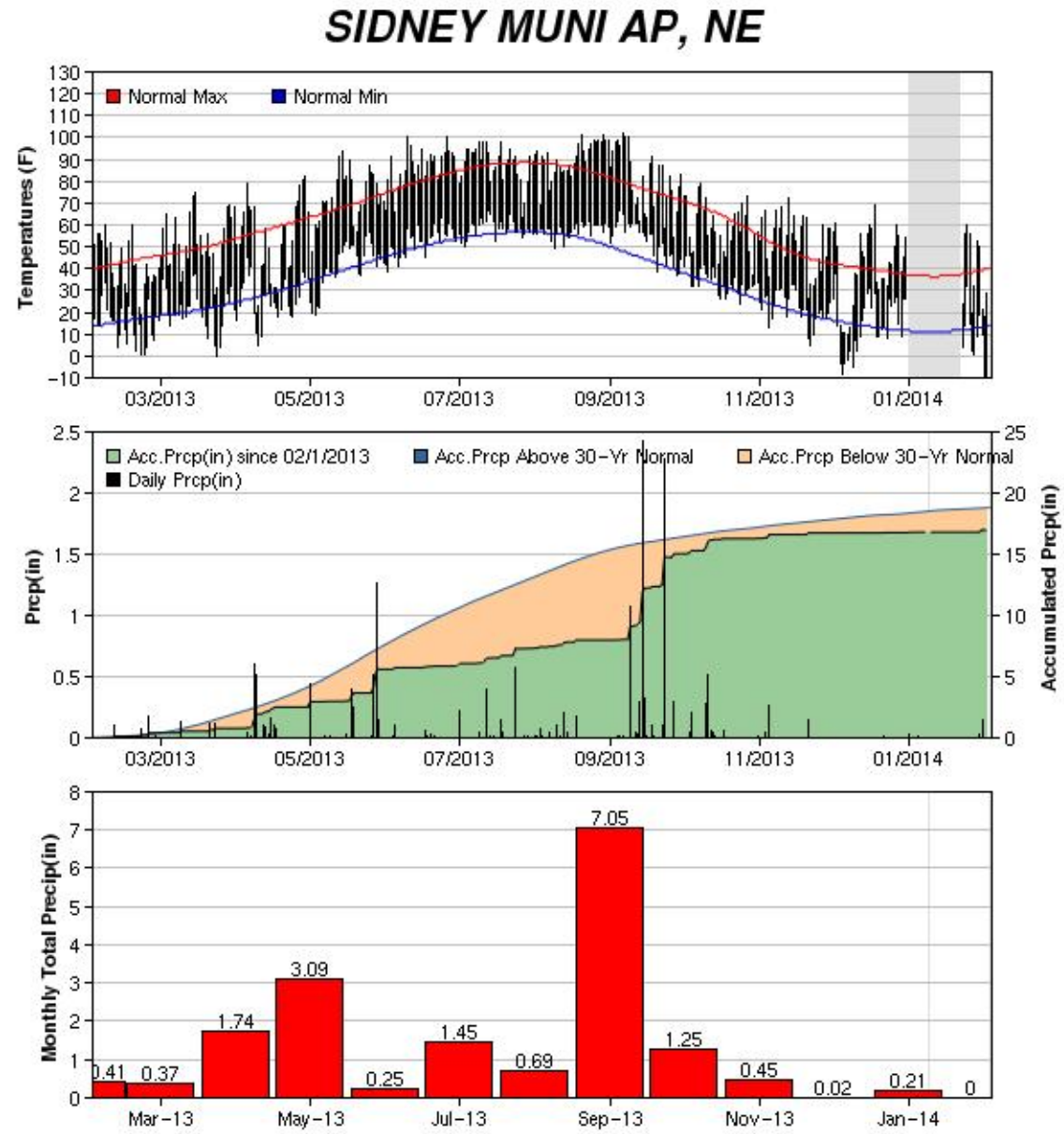


The top graph shows the "normal" daily maximum and minimum temperatures along with the daily maximum and minimum values for the 2013-weather year. Note that the similar trend of a very cool March and April followed by generally warmer period beginning late May and early June. The July temperatures were about normal to a little cooler. August appeared to be somewhat cooler, but was followed by a considerable warm-up, and with much above normal temperatures for September. October brought much cooler temperatures with a slight warming in November, but a return to a cold period in December.

The precipitation graphs show a drier than average Jan. and March with a slightly wetter Feb. Rainfall was just slightly above average for April and May, but was slightly drier than average for June. July 2013 was considerably above average for July, but drier than average in August. September brought the very high rainfall and floods and logged 8.44 inches of rain. The fall rains were just slightly above average, but ended in a below average December. The cumulative graph show the rainfall just staying at or above average until the good rains in July, and, of course, stayed substantially above average after the September rain. Overall for the calendar year it shows the annual total for the **SIDNEY 6 N** to be **25.35 inches** or a plus **8.56 in above** the long-term average of **16.79 inches** for this station. (see Table 1 and additional graphs for details)

The following graphs show the similar data for the **SIDNEY 3 S** station. There were some significant differences between the two stations in precipitation. The 3 S station was drier than average for the March through August period with June being very dry. The big rain in September brought this yearly amount up, but the overall total for the year was only **16.94 inches or 1.95 inches below the average of 18.89 inches.** The cumulative precipitation graph show that the rainfall was running below average for the entire year, and even with the extremely wet September, the annual total logged below the average for this site.

The temperature graph shows the similar cold period in March and April, followed by about normal warming in late May into June. The temperatures moderated in July, but late August and, of course, early September brought the same major heat of the summer.



Normals based up 1971-2000 Normals, if available *"Experimental" May Contain Preliminary Data*
Grey Shading indicates where data are flagged as 'Missing' *High Plains Regional Climate Center*
Accumulated Precip (where available) may not reflect actual deviations from normal if data are missing *http://hprcc.unl.edu*

TABLE 1.

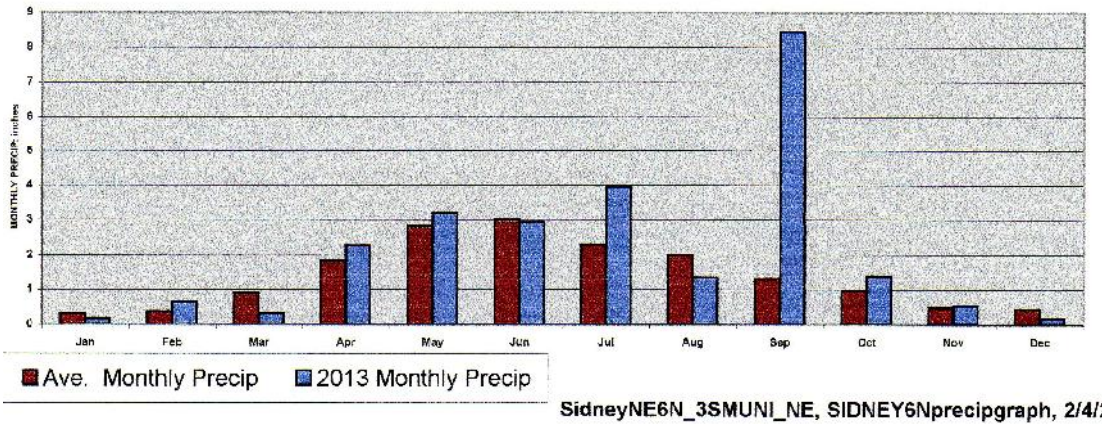
SIDNEY 6 N, NEBRASKA (257830) Period of Record: 12/1/1908 to 3/31/2013

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39.3	43.6	50.2	60.4	69.7	80.5	88.9	86.3	77.6	65.4	50.5	41.7	62.0
Average Min. Temperature (F)	12.0	15.9	22.2	31.3	41.5	51.0	57.6	55.6	45.1	33.3	21.7	14.8	33.5
Average Total Precipitation (in.)	0.31	0.38	0.91	1.83	2.83	3	2.3	1.99	1.32	0.96	0.49	0.45	16.79
Monthly Precip. 2013 from graph	0.17	0.64	0.32	2.27	3.18	2.93	3.95	1.35	8.44	1.38	0.54	0.17	25.35
DEPARTURE>>	-0.14	0.26	-0.59	0.44	0.35	-0.07	1.65	-0.64	7.12	0.4	0.05	-0.28	8.56
Average Total SnowFall (in.)	4.2	4.4	6.7	4	0.5	0	0	0	0.2	1.7	4	4.5	30.6

SIDNEY 3 S, NEBRASKA (257835) Period of Record: 6/1/1948 to 3/31/2013

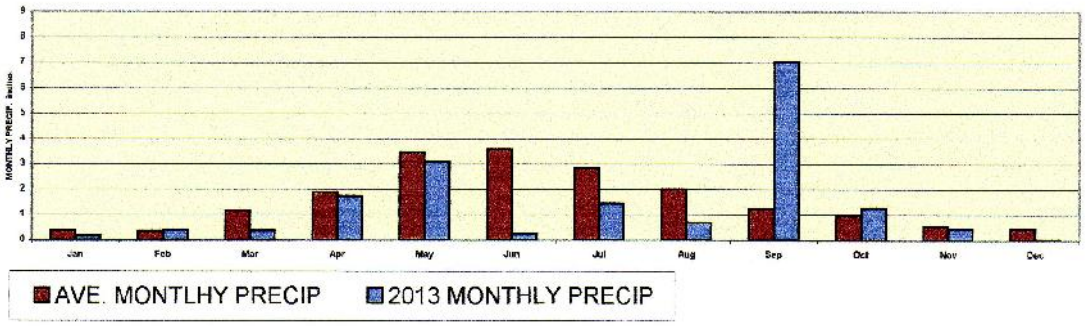
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	37.9	42.8	49.4	59.0	68.6	80.0	87.9	86.2	75.3	64.5	48.9	40.5	61.7
Average Min. Temperature (F)	11.9	15.5	20.8	30.3	40.7	50.3	58.9	55.1	44.5	32.7	20.6	13.9	32.7
Average Total Precipitation (In.)	0.39	0.35	1.16	1.88	3.45	3.58	2.84	2.01	1.23	0.98	0.55	0.45	18.88
Monthly Precip. 2013 from graph	0.17	0.41	0.37	1.74	3.09	0.25	1.45	0.66	7.05	1.25	0.45	0.02	16.94
DEPARTURE>>	-0.22	0.06	-0.79	-0.14	-0.36	-3.33	-1.39	-1.35	5.82	0.27	-0.1	-0.43	-1.95
Average Total SnowFall (in.)	5.5	4.3	9.5	6.4	1.3	0	0	0	0.2	2.3	6.2	5.3	41.3

MONTHLY PRECIPITATION 2013 AND 1908-2013 AVE.
SIDNEY 6 NNW, NEBRASKA



SidneyNE6N_3SMUNI_NE, SIDNEY6Nprecipgraph, 2/4/2014

MONTHLY PRECIPITATION: 2013 and 1948-2013 Ave.
SIDNEY, NEBRASKA 3S (MUNI)



SidneyNE6N_3SMUNI_NE, SIDNEY3Sprecipgraph, 2/4/2014

Cover Crop Water Use and Impacts on Wheat Yields in the Central Great Plains

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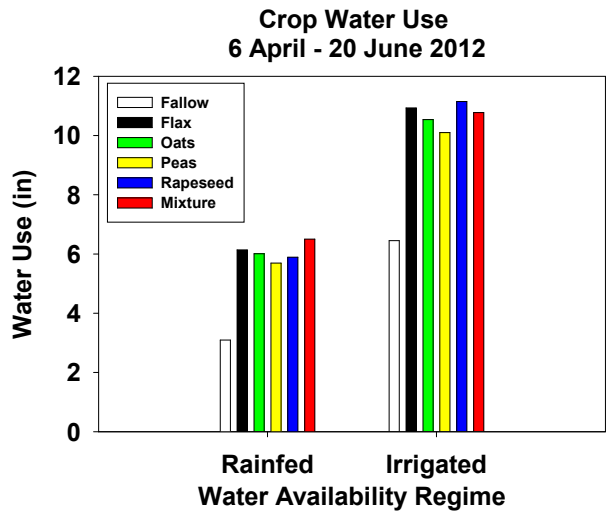
Do cover crop mixtures or cocktails use less water than a single-species cover crop? Do cover crops reduce evaporation losses enough to make up for their water use? Do cover crop mixtures improve soil biological activity in a semi-arid environment? These questions and others are being asked as interest in using cover crops to improve cropping practices grows across the United States. Cover cropping as a farming practice has, in the past, been defined as growing a crop between the regular grain crop production periods in order to protect and improve the soil. It has also been referred to as "growing green manure" or (in the semi-arid Great Plains) "practicing green fallow". Until recently this definition meant that the cover crop was not used for any direct economic benefit, but currently the term seems to have broadened to include systems which use the cover crop biomass for livestock grazing or even direct sales of some of the biomass produced. Cover crops can consist of grasses, legumes, oilseeds, and other broadleaf plant species and can be planted in either fall or spring.

Some of the generally reported benefits of growing a cover crop are increased organic matter in the surface soil layer, improved soil structure and infiltration, reduced surface soil water evaporation, protection from wind and water erosion, increased snow catch, production of nitrogen, increased soil biological activity, increased nutrient availability, reduced nutrient loss, alleviating compaction, suppression of weeds, insects, and diseases, and improved water availability for subsequent crops. Many of these benefits have been reported in areas that receive more precipitation and have greater humidity than the Central Great Plains. Unfortunately, it is well documented in the scientific literature that an inch of crop water use will produce much less plant biomass in Texas than in North Dakota due to the lower humidity and greater evaporative demand in Texas compared with North Dakota. Consequently, what might work as a cover cropping practice in North Dakota might not work in regions further south, even when precipitation is similar. Many of the beneficial effects reported as a consequence of growing cover crops have not been rigorously verified with scientific trials in the semi-arid environment of the Central Great Plains. In particular there have been some claims made regarding the ability of cover crops grown in multi-species plantings of at least 8 species (sometimes referred to as cocktail mixes) to produce significant amounts of biomass while using almost no water.

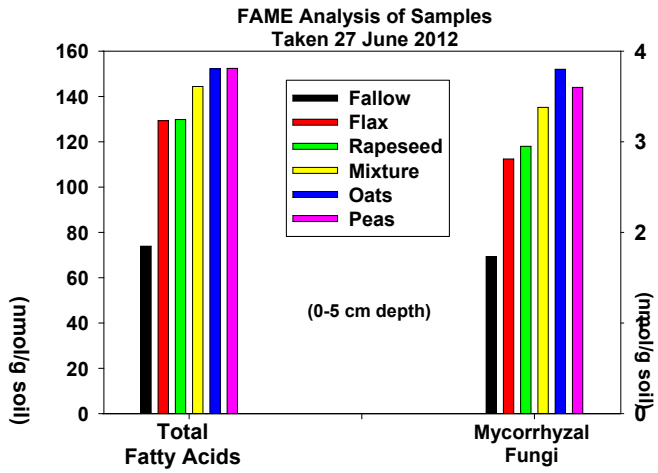
This claim was recently tested at both Akron, CO and Sidney, NE by growing spring-planted cover crops in proso millet residue in a no-till system under several water

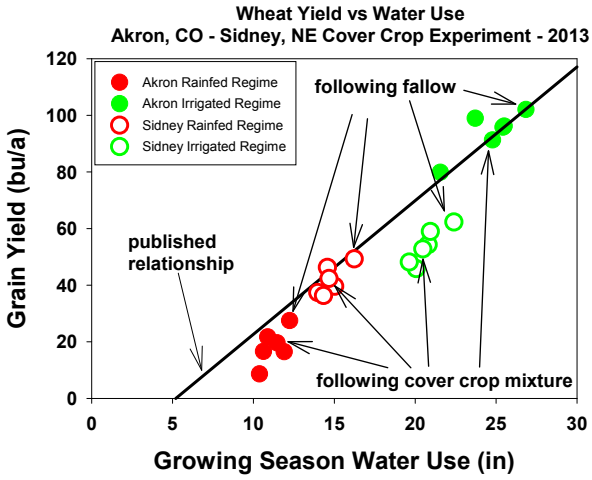
availability conditions ranging from rainfed to nearly non-water-stressed conditions. The cover crop treatments consisted of single-species plantings of oats, peas, flax, or rapeseed, and a 10-species mixture of those same four crops plus lentils, vetch, clover, barley, safflower, and phacelia.

The figure to the right shows the growing season water use for the cover crops grown at Akron from planting to termination in 2012. The white bar indicates 3.1 inches of evaporation in the fallow plot under the dryland water treatment, and 6.5 inches of evaporation under the irrigated treatment. Greater amounts of water use occurred for the cover crop treatments, but all used approximately the same amount of water (6.1 inches for the rainfed treatment, 10.7 inches for the irrigated treatment. Values intermediate to these were observed at Sidney. What is clear from the figure is that the cover crop mixture did not use less water to grow biomass than the single-species plantings.



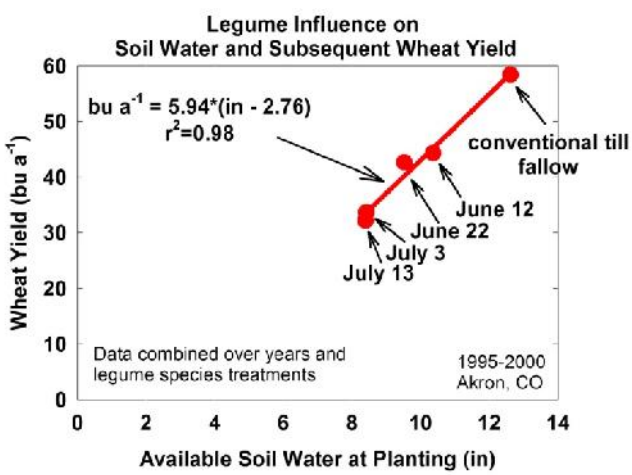
We also analyzed soil samples for 16 microbiological populations, two of which are shown in the figure to the right for the study at Akron. These samples were taken in the 0-5 cm surface soil layer (0-2 inches) just after termination of the cover crop. As expected, both the numbers of total fatty acids and mychorrhyzal fungi were greater where there was a growing crop with living roots compared with the fallow plot. However, there was not greater biological activity where cover crops were grown in the mixture compared with single-species cover crop plantings.





The water use and yields of the wheat following the cover crops grown at both Akron and Sidney under the two water availability regimes are shown in the figure at the left. The water use/yield production function previously found applicable to wheat grown at Akron is shown as the solid black line. The points from the irrigated treatment at Akron and the rainfed treatment at Sidney fit the relationship well. The points for the rainfed treatment at Akron fall

below the line due to a late-season hail storm that resulted in some seed shattering. There is at present no explanation for why the irrigated points at Sidney fall below the line, but the slope of a line drawn through those points is nearly the same as the solid black line (about 4.8 bu/a per inch of water used). The arrows indicate the comparison between yield and water use of wheat following fallow and wheat following the cover crop mixture for each of the four data sets. The other data points are from wheat following the single-species plantings of flax, rapeseed, oats, and peas. It is clearly evident from this comparison that the cover crop mixture resulted in lower water use (because of less soil water available at planting due to the previous cover crop water use) and lower wheat yield than found with wheat after fallow. The presence of the cover crop mixture ahead of the wheat crop did not result in more water available and greater yields, nor did the cover crop mixture alter the water use efficiency of wheat production, which would be indicated if the points for the cover crop mixture treatment were above the other points in each of the four groups in the figure. It is also clear from the figure that all cover crops, whether grown as single species or in a mixture, use water causing reduced water availability and water use for the subsequent wheat crop resulting in decreased yield compared with wheat following fallow.



Because the relationship between wheat water use and yield is the same for both single-species plantings and for the mixture (figure above), we can be confident in the applicability to the current discussion of some previously published data on single-species legume cover crop water use effects on wheat yield. The figure to the left shows the 6-yr average decline in soil water availability due to legume cover crop water use. Available water at wheat planting declines as termination of the cover crop is delayed. This reduction in available soil water at wheat planting reduces subsequent wheat yield by 5.94 bu/a for every inch of water used by the cover crop that is not replenished prior to wheat planting. Additionally the figure indicates that even when a cover crop is terminated early (June 12, 105 days prior to wheat planting) there will be a significant yield loss. In this case the yield loss was 24% (compared with wheat yields following a conventional till fallow period). When the cover crop was terminated on July 3 (84 days prior to wheat planting) the yield loss was 42%. We would expect the yield losses to be greater had they been compared with wheat grown following a no-till fallow period.

Cover Crop Seed Costs

The Table below indicates the costs of the cover crop seeds used in this study and the recommended planting rates and total seed costs per acre (ranging from $6/acre to $40/acre). Also indicated is the cost

Single Species

Species	*$/lb*	Target Rate *lb/a*	*Total ($/a)*
Peas	$0.40	100	$ 40.00
Lentils	$0.65	50	$ 32.50
Vetch	$0.80	50	$ 40.00
Clover	$2.15	15	$ 32.25
Oats	$0.29	90	$ 26.10
Barley	$0.31	90	$ 27.90
Rapeseed	$1.00	6	$ 6.00
Flax	$0.65	35	$ 22.75
Safflower	$0.70	30	$ 21.00
Phacelia	$4.45	5	$ 22.25

Costs to plant the seed mixture at 52 lb/a

Seed $ 34.29/a
Mixing $ 26.00/a *$0.50/lb*

Total $ 60.29/a

of the cover crop mixture ($60.29/acre) which included a seed mixing cost ($0.50/lb) assessed by the seed provider. In addition to these costs would be the costs of inoculant for the legumes, planting costs, and the costs associated with the loss of income due to the yield reduction caused by the cover crop water use. Some of these costs would, of course, be offset if the cover crop could be grazed or a portion of it harvested and sold. However, those actions would likely result in a reduction in some of the benefits normally attributed to having cover on the soil surface as stated at the beginning of this article.

Dryland farmers in the semi-arid Central Great Plains should approach the use of cover crops with some caution, considering several factors:

1. All of the beneficial effects of cover crops that are reported from their use in more humid environments may not be observed in this region due to the greater evaporative demand.
2. Experimental results of studies done in this region indicate that there will likely be a significant yield depression on the following wheat crop from growing a cover crop, even if termination of cover crop growth occurs fairly early (e.g., mid-June)
3. Any beneficial effects (improved soil health, increased nitrogen availability) of growing the cover crop will need to be weighed against the economic consequences associated with the cover crop seeding costs and the yield drag in the subsequent wheat crop
4. There appears to be no evidence of superior beneficial effects to recommend the additional expense associated with growing a cover crop mixture vs. a single-species cover crop planting.

Genetic Mapping of Agronomic Traits in Proso Millet

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Introduction

Proso millet (*Panicum milliaceum*) is an allo-tetraploid cereal crop grown in USA, China, Russia and other parts of the world. In USA it is mainly grown as rotational crop in wheat based dryland cropping system. It is predominantly used as birdseed in US but it is being used as human food in many other countries such as China, Japan, Korea and recent time in the USA also. Proso millet production in western Nebraska suffers from to lodging, seed shattering, non-uniform maturity etc. which reduce proso millet yield significantly. In some cases farmers have no crop produce due to above mentioned problems.

Phenotype of the plant is combination effect of genetics and environment. Many economically important crops such as corn, wheat, rice are extensively studied for genetics and environment. There are hundreds of the published reports showing the gene inheritance, their interactions and expression studies. Sometime these genes are governed by single gene or many genes. Plant breeder has to study the inheritance pattern of the existing genes and breed the crop for specific needs. In order to improve proso millet yield new cultivars need to be developed using available germplasm. Very few reports are published on proso millet. Hayduck et al (2008) reported agronomic trait evaluation in proso germplasm but it is not used effectively in proso improvement. So far, only one paper reported waxy locus inheritance in proso millet (Graybosch and Baltensperger 2009). There is no study reported for any other agronomical trait inheritance in proso millet.

Successful cultivar improvement needs knowledge and understanding of yield, other agronomic traits and their inter-relationship. Multi-location genetic studies for evaluating agronomic characters have provided valuable information to plant breeders (Bernard et al 2002). Improved proso cultivars will definitely increase the area and production in the region. Systematic study on genetics and inheritance can provide insight about the agronomical traits and their introgression to produce better hybrids for future.

The objective of this study is to observe the genetic variation and genetically map genes of six important agronomic traits using Huntsman x Minsum recombinant inbred (RIL) line population.

Material and Methods

Plant material and Experimental design

In 2011, F_1 cross was made between Huntsman and Minsum in the greenhouse at the Panhandle Research and Extension Center. Huntsman (PI578074), a variety developed by University of Nebraska is the high yielding, compact head, medium to late maturity variety developed mostly for western Nebraska climate. Minsum is the variety released by University of Minnesota in 1980. It is early maturing, open panicle type and less tolerant to lodging. We selected these parents because of many contrasting characters between them.

The F_1 hybrid of Huntsman x Minsum cross was allowed to self to generate F_2 seeds. F_2 seeds were harvested and identity of every plant was maintained to create $F_{4:5}$ lines through single seed descent (SSD) method by continuous selfing of individuals at each generations. Total 250 $F_{4:5}$ recombinant inbred lines (RILs) were grown as a single head row in the field at Sidney and Scottsbluff location in 2013 from June to Sept. In Sidney we grown this trial as dryland whereas it was irrigated trial in Scottsbluff. To maintain the uniformity and reduce the experimental errors we weighed 1 g seed was planted as 5 foot long row with 1 foot distance between the rows. Entries were laid out in a randomized complete block design (RCBD) with 4 and 3 replications at Sidney and Scottsbluff locations, respectively. Huntsman and Minsum were planted as checks 5 times in every replication. Seeds were harvested in Sept 2013.

Data collection

Total six important agronomics traits heading date, plant height, lodging, shattering, panicle length and seeds/panicle were recorded on 250 RILs. Heading Date (HD) was taken on 35th day onwards till 50% of the plants from all head row completed heading (i.e. heads coming out from the flag leaf). Plant height was measured in inches using yard stick. Lodging was recorded as % plants lodged/per head row and the angle of lodging. This data was then converted to lodging score. Shattering was recorded by measuring proso millet grain pedicel breaking tensile strength (BTS) in gram using Shimpo Digital force gauge FGV-2XY. We used our own customized stand with paper clip for this process. To reduce the errors entire assay was performed by one person. Proso millet panicle was attached upside down to the digital force gauge and three seeds (top, middle and bottom portion of the panicle) were pulled by forcep. At the moment seed detachment maximum tensile strength was recorded manually. Panicle length was measured as length from topmost seed to the first branch (from down) in inches. Seeds were cleaned and no of seeds/panicle were counted using the seed counter. In Scottsbluff, birds damaged 2 replications so we skipped ANOVA for seeds/panicle.

Statistical analysis

Analysis of Variance (ANOVA) and GXE for all the six traits were performed for each individual location and analyzed as random complete block design using generalized liner model (GLM) procedure of SAS 9.2 (SAS Institute, 2008). Pearson's co-relation was done using PROC CORR of SAS.

Result and Discussion

An important step in the analysis of genetic effects is the evaluation of the trait frequency distribution. This distribution represents the degree of genetic variability and is informative of some trait properties (D'Andrea 2013). Frequency distribution of the traits in Huntsman x Minsum population indicated that all the six traits seem to have polygenic/quantitative inheritance (Figure 1.). Four out of six traits showed statically significant differences among the RILS, revealing that they are different among the parents and are heritable.

Analysis of Variance (ANOVA) for all the traits showed that shattering Scottsbluff location only), panicle length, plant height and heading date are statically significant among the RILs except, lodging and seeds/panicle (Table 1). Seed shattering is highly significant among the RILs in Scottsbluff location but it is not statically significant in Sidney location. Panicle length, Plant height and heading date are highly significant in both the locations. Lodging and total seeds/panicle were not significantly different among the RILs. These significant differences among the RILs showed that genetic background is contributing towards different degree of expression of the traits. We found transgressive segregation almost all the traits which is good indication that we can improve these traits through good allelic combinations. This needs to be validated in other genetic backgrounds and in multi-location multi-year trials. The observed variation among RILs can be beneficial and have practical application in proso breeding program.

Co-relation coefficients were estimated for each pair-wise combination of agronomic traits in RILs at each location separately (Table 2). Most of the traits are highly co-related to each other. There are differences in both the locations. In Sidney heading date is negatively correlated with panicle length and plant height (<0.0001). Shattering is having negative co-relation with plant height and lodging. This is expected in general sense. When plant height increases it is more prone for lodging in high winds which results in more shattering due to friction between adjacent plants and detachment of the seeds from the panicle. At Scottsbluff location lodging is negatively co-related (-0.32) with plant height and is highly significant (<0.0001). These results are expected for quantitative traits since they are governed by many genes. From the co-relation we can estimate contribution of different factors in the expression of the traits. We found these traits have different relationship in both the environments.

Quantitatively inherited traits are highly affected by environments. The 250 RILs are showing that shattering is not significant in Sidney while it is significant in Scottsbluff. This might have happened by genotype by environment interaction. Analysis for GXE for shattering and all other traits showed that it is significant at 0.02 and 0.0001 probability for shattering and panicle length, respectively. All other traits are not showing significant genotype by environment interactions. These GXE interactions might have happened due to dryland and irrigated trials in both the locations. When the quantitative trait is affected by GXE interaction it complicates the analysis and it is hard to breed since it varies environment to environment.

The Huntsman x Minsum RIL population performed well and gave insight about the heritability of the different agronomical traits. This is the first report of genetics and inheritance study for agronomical traits in proso millet.

Table 1: ANOVA table for six agronomical traits evaluated in 2013 in Huntsman x Minsum population

	Sidney				Scottsbluff			
	Mean	SD	Range	ANOVA	Mean	SD	Range	ANOVA
Shattering	7.66	3.4	2.66-17.5	NS	8.14	6.84	1-39	<0.0001****
Panicle length	6.42	0.4	5.3-9.0	<0.0001****	5.94	0.5	4.0-9.0	<0.0001****
Lodging	2.36	4.0	0-22.5	NS	26.03	31.64	0-90	NS
Plant height	28.82	1.7	23.4-35.8	<0.0001****	25.46	2.27	18-31	<0.02*
Heading date	53.54	1.1	45.7-55.7	<0.0004****	42.15	1.13	35.3-45	<0.0001****
Seeds/Panicle	400.15	179	207-637	NS	416	139	149-895	-

* Significant at 0.05 level; **** Significant at 0.0001 level; NS: Not significant

Table 2: Pearson co-relation coefficients among six agronomical traits

	Heading	Plant Height	Lodging	Panicle length	Shattering	Seeds/Panicle
Heading	1	-0.28418****	-0.05461	-0.54823****	0.01036	-0.02280
Plant height		1	0.03436	0.36214****	-0.04334	0.10746
Lodging			1	0.05279	-0.05057	0.07669
Panicle length				1	0.07218	0.01990
Shattering					1	-0.07893
Seeds/panicle						1

**** Significant at 0.0001 level;

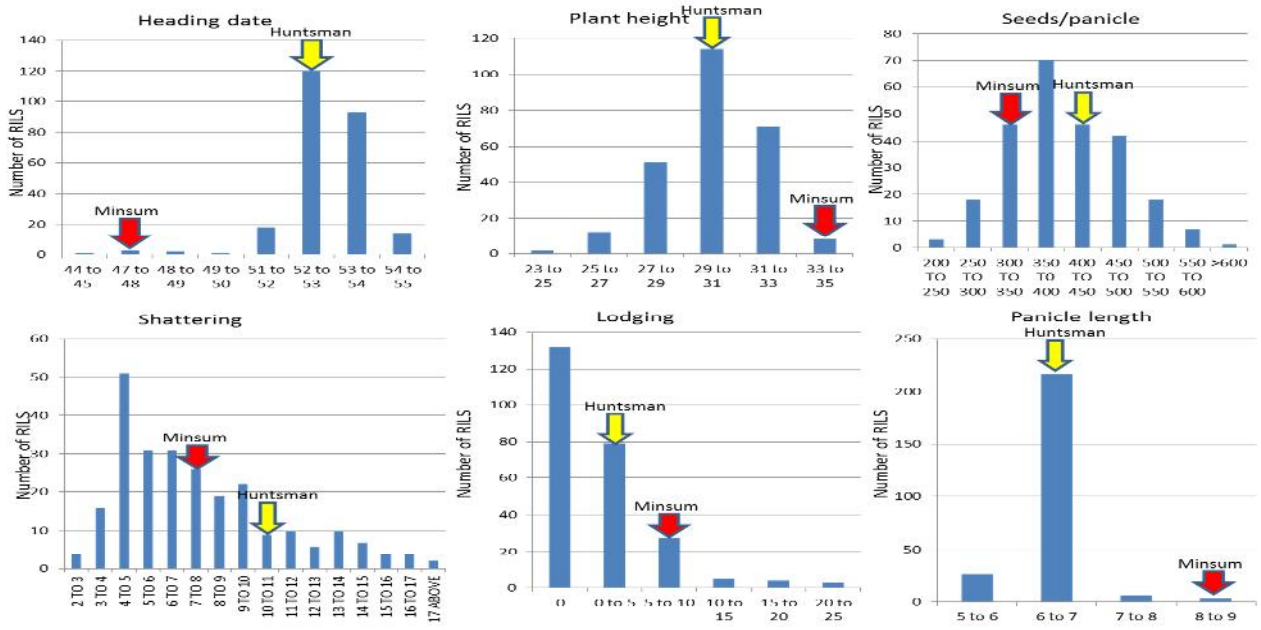

Figure 1: frequency distribution of six agronomical traits evaluated in 2013 in Huntsman x Minsum population

Proso Millet, Sunflower and Pea: 2013 Variety Testing Results

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Research goal and objective

Overall goal was to identify alternative crops cultivar with high yield potential in western Nebraska. Objective in 2013 was to evaluate proso millet, sunflower and pea (also called field pea or yellow pea) varieties in High Plains Ag. Lab. The results are summarized below.

Proso millet

Thirty one proso millet lines (24 advanced breeding lines and 7 check cultivars) were planted under dryland no-till condition with 4 replications as 5' x 30' plot on June 11, 2013. Previous crop of the plot was winter wheat. Before planting, the plot was applied with 45 lbs N and 32 oz Roundup per acre. The trial was harvested on October 21, 2013 using Winter Steiger Delta small plot combine and result is shown in the Table-1.

Table 1. Panhandle Proso Millet Variety Test in Cheyenne County 2013.

Variety Name	Yield* (lbs/a)	Bushel Weight (lbs/bu)	Moisture at harvest (%)
177-9-13	1883	52	14
182-5-18	1801	52	14
5029	1369	51	14
Earlybird	1332	52	14
Dawn	1325	53	14
Sunrise	1313	50	14
5106wx	1289	52	14
172-2-B	1278	53	14
5045wx	1236	52	14
174-7-13	1205	52	14
5094	1203	50	14
177-3-13	1165	54	14
Plateau	1155	53	14
182-4-24	1130	52	14
Horizon	1116	52	14
5034wx	1105	51	14
5095wx	1091	51	15
5059wx	1038	52	14

Ames 12696	1032	52	14
5016	1031	52	14
Sunup	1030	52	14
5011wx	1022	51	14
5014	1018	52	14
5086	1017	52	14
5002wx	982	51	14
5061wx	933	51	14
177-8	932	52	14
Huntsman	923	51	14
5100	915	53	14
5087wx	915	51	14
5104wx	896	51	15
Mean	**1151**	**52**	**14**
LSD§ (0.05)	**49**	**2**	**1**

**Adjusted for 12% moisture*

§ *Least Square Difference. Two varieties are different if the trait value differs by the LSD*

Sunflower

Three sunflower trials, which were conducted in 2013 are: (1) oil type under dryland – Table 2, (2) oil type under irrigation – Table 3, and (3) confection type under irrigation – Table 4. Results were presented in Table 2, 3, 4, and 5, respectively. Plant population of 17,500/acre was used for dryland oil and irrigated confection; and 22,000/acre was for irrigated oil trial.

Table 2. Nebraska Sunflower Variety (Oil) Test - 2013 (Cheyenne County, Dryland)

Brand	Hybrid	Oil Type*	Yield** (lbs/a)	Bushel Wt (lbs/a)	Flowering in August	Plant Height (inches)
Syngenta	3845	HO	1530	24	8	67
Mycogen	8N668S	NS	1477	25	8	67
Seeds 2000	Torino X9978	NS	1379	25	8	66
Seeds 2000	NHK12M010	HO	1379	23	8	67
Syngenta	3158 NS/CL/DM	NS	1361	24	8	67
Winfield	548CL	NS	1308	24	8	67
Mycogen	8H449CLDM	HO	1249	25	8	68
Mycogen	8N510	NS	1133	25	8	69
Winfield	13-86E	NS	1119	24	8	69
Winfield	13-652CL	HO	1118	23	8	68
Winfield	13-59CL	NS	1111	23	8	68
Mycogen	8N421CLDM	NS	1067	21	8	68
Seeds 2000	NLK12M008	NS	1057	23	8	67
Winfield	460E	NS	1055	25	8	67
Winfield	13-52E	NS	1047	23	7	69

Syngenta	3733 NS/DM	NS	1036	24	8	69
Winfield	559CL	NS	1017	25	8	68
Winfield	13-08CL	HO	936	23	8	68
Winfield	432E	NS	695	24	8	68
Mean						
LSD§ (0.05)						

**Adjusted for 10% moisture*

*** C=Confection; NS = NuSun; HO = High Oleic; T = Traditional*

§ *Least Square Difference. Two varieties are different if the trait value differs by the LSD*

Planted: 06/20/2013; Previous crop: Winter wheat; Fertilizer: 45 lbs N/acre; Herbicide: 2 Pints Prowl H_2O, 2.5 oz Spartan Pre Plant; Harvested: 10/30/2013

Table 3. Nebraska Sunflower Variety (Oil) Test - 2013 (Cheyenne County, Irrigated)

Brand	Hybrid	Oil Type*	Yield** (lbs/a)	Bushel Weight (lbs/bu)	Flowering in August	Plant Ht (inches)
Syngenta	3733 NS/DM	NS	1947	24	16	71
Seeds 2000	NLK12M008	NS	1924	23	15	70
Seeds 2000	CamaroII X6878	NS	1897	23	15	70
Seeds 2000	Falcon	NS	1874	24	16	69
Seeds 2001	Torino X9978	NS	1866	23	14	17
Winfield	13-652CL	HO	1860	23	14	60
Winfield	13-86E	NS	1859	23	16	75
Syngenta	3845	HO	1839	23	14	70
Winfield	432E	NS	1629	23	14	70
Mycogen	8N510	NS	1610	24	16	70
Winfield	548CL	NS	1581	24	16	72
Mycogen	8H449CLDM	HO	1572	23	17	70
Winfield	13-59CL	NS	1570	24	15	70
Seeds 2000	CobaltII X6822	HO	1568	24	16	71
Mycogen	8N421CLDM	NS	1565	23	14	70
Winfield	13-52E	NS	1565	24	14	68
Mycogen	8N668S	NS	1556	24	14	70
Winfield	559CL	NS	1553	23	14	70
Syngenta	3158 NS/CL/DM	NS	1542	23	17	70
Seeds 2000	NHK12M010	HO	1537	24	14	70
Winfield	13-08CL	HO	1520	23	15	71
Winfield	460E	NS	1504	22	16	70
	Mean		1679	23	15	70
	LSD§ (0.05)		4	1	3	1

**Adjusted for 10% moisture*

*** C=Confection; NS = NuSun; HO = High Oleic; T = Traditional*

§ *Least Square Difference. Two varieties are different if the trait value differs by the LSD*

Planted: 06/14/2013; Previous crop: Winter wheat; Fertilizer: 45 lbs N/acre; Herbicide: 2 Pints Prowl H_2O, 2.5 oz Spartan Pre Plan; Harvested: 11/07/2013

Table 4. Nebraska Sunflower Variety (Confection) Test - 2013 (Cheyenne County, Irrigated)

Brand	Hybrid	Yield* (lbs/a)	Bushel Wt (lbs/bu)	Flowering August	Plant Ht. (inches)	Seed Size >22/64 %	Seed Size >20/64 %
Nuseed Global	NHW734	1660	22	10	70	14%	48%
Sunopta/Dahlgren	9592CL+	1658	22	12	70	14%	48%
Nuseed Global	X98578	1657	20	8	70	10%	49%
Nuseed Global	NHW 735	1657	23	10	70	13%	48%
Seeds 2000	NSK12M048	1657	21	8	70	15%	47%
Seeds 2000	Jaguar	1656	21	8	70	11%	46%
Sunopta/Dahlgren	9521	1656	21	10	70	14%	46%
Sunopta/Dahlgren	9579	1656	21	8	70	23%	47%
Nuseed Global	5009	1655	21	10	70	11%	46%
Seeds 2000	X4334	1652	21	8	70	13%	49%
Seeds 2000	Jagaur II	1501	22	12	70	18%	45%
Sunopta/Dahlgren	9530CL	1501	22	10	69	23%	47%
Nuseed Global	NHW 12731	1497	22	8	69	8%	45%
Nuseed Global	NHW 12806	1344	21	8	69	16%	48%
Nuseed Global	NHW 12774	1339	21	8	71	14%	45%
Nuseed Global	NHW 12810	1339	22	8	70	16%	49%
Nuseed Global	NHW 12703	1337	22	12	69	15%	48%
Seeds 2000	Jaguar XL	1337	22	9	70	15%	47%
Sunopta/Dahlgren	9599	1336	22	8	70	24%	50%
	Mean	**1531**	**21**	**9**	**70**	**16**	**47**
	LSD§ (0.05)	**105**	**1**	**1**	**2**	**15**	**4**

**Adjusted for 10% moisture*

§ *Least Square Difference. Two varieties are different if the trait value differs by the LSD*

Planted: 06/10/2013; Previous crop: Winter wheat; Fertilizer: 40 lbs N/acre; Herbicide: 2 Pints Prowl H_2O, 2.5 oz Spartan Pre Plan; Harvested: 11/24/2013

Pea (also called field pea or yellow pea)

Pea has known as adapted alternative crop for rotating with winter wheat in western Nebraska. However, no significant pea production happened because of lack of market until 2013. There has been new interest in 2013 for pea production due to new international export market in for human food. The new initiative was spearheaded the 'State Line Bean', a local seed handling company. This is the first year of evaluating commercial pea varieties in response to the new interest in pea production in the region and the result is presented in Table 5.

Table 5. Nebraska Pea Variety Test - 2013 (Cheyenne County, Dryland)

Brand	Variety	Yield (lbs/a)	Bushel Wt (lbs/bu)	Flowering (June)	Plant Height (inch)
Meridian Seeds, ND	Agassiz	1852	60	14	19
Pulse USA, ND	DS Admiral	1846	61	14	18
USDA-ARS, Pullman	PS08101004	1779	58	14	18
USDA-ARS, Pullman	Universal	1707	59	15	18
Northern Great Ag.	Salamanca	1690	59	15	18
USDA-ARS, Pullman	PS07100925	1681	59	15	14
USDA-ARS, Pullman	PS08101022	1613	61	15	15
Meridian Seeds, ND	Jetset	1579	60	14	19
Pulse USA, ND	SW Midas	1558	60	14	17
Pulse USA, ND	Nette	1554	61	15	19
Legume Logic, ND	Spider	1552	60	15	20
Meridian Seeds, ND	Thunderbird	1547	60	15	20
Northern Great Ag.	K2	1513	58	14	18
USDA-ARS, Pullman	Carousel	1470	58	14	17
USDA-ARS, Pullman	PS03101822	1443	58	17	15
Legume Logic, ND	Bridger	1392	59	14	17
Pulse USA, ND	Korando	1365	61	14	16
Northern Great Ag.	Navarro	1287	51	14	17
	Mean	**1579**	**59**	**15**	**18**
	LSD[§] (0.05)	**300**	**5**	**1**	**3**

[§] *Least Square Difference. Two varieties are different if the trait value differ by the LSD*

Planted: 04/03/2013; Previous crop: winter wheat; Plant population: 350,000 live seeds/acre; Inoculum: Seed was inoculated with 'InTake Microbial @ 1.75 oz/50 lbs; and Harvested: 08/01/2013.

Small Grain Breeding Research at High Plains Ag. Lab

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Nebraska is known for its diverse climate and geography. There is as much ecogeographic variation from Omaha to Scottsbluff as there is from Omaha to Washington, D.C. However the state can be broken into three main wheat growing regions: the east, the southwest, and the Panhandle. Because we lose crops to winterkilling, drought, and hail, we try to have at least two testing locations in each major region so that if we lose one of them, we still will have data from the other location to represent the region. In the east, the testing locations are at Lincoln and Clay Center with a major nursery for selecting winterhardy lines at Mead. In the southwest, our testing sites are North Platte and McCook (on a grower's field) and will include the recently donated farm at Grant. In the Panhandle, our trials are at the HPAL and at Hemingford (on a grower's field). When we are on grower's fields, we limit our experiments to those which cannot impact the grower's future or limit how he or she will use their land after the plots rotate. For example, we never would grow rye or triticale on a grower's field because it may volunteer after our research is harvested. Similarly we would never put a transgenic line on a grower's field for fear it may also volunteer and enter the commercial grain trade.

At the HPAL, because we are on University land, we test our winter wheat, winter barley, and winter triticale breeding lines for grain and it is the largest testing site outside of Lincoln and Mead. Winter barley and triticale are excellent alternative crops for small grains producers. For example barley is immune to karnal bunt should that disease ever come to Nebraska. We have excellent collaboration at the HPAL so in addition to our grain trials, we have our winter forage triticale trials and the winter barley trials are harvested by the staff at HPAL. That winter forage triticale trials and the winter barley trials are harvested by the HPAL staff is critical because it is very cost effective and timely to harvest the forage triticale plots in one afternoon rather than send a crew from Lincoln for 4 hours worth of work. The barley grain plots being harvested by HPAL is critical because the western barley harvest coincides with the main wheat harvest in eastern Nebraska so all of the eastern combines are cutting wheat. Unlike wheat which can stand in the field after maturity, barley seems to cannibalize the plant and put all of its reserves into the grain. Relatively mild wind storms or rain will snap and break the barley heads, thus shattering the grain on the ground. To have reliable barley yield data, barley must be harvested on time.

In 2013, we had a rough year at Sidney. The trials were planted on time and emerged well, but were plagued by drought thereafter. In the winter, rain and ice storms killed many of the weaken plants and it was decided to abandon the main yield trials. We were able to harvest the State Variety Trial and the Triticale Forage Trial. In the fall, the 2014 trials were planted on time and it appears going into winter they were doing well.

We thank the growers and the Nebraska Wheat Board for their support of this research.

Ecology of the wheat curl mite and Epidemiology of its Vectored Viruses

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Establishing risk for alternative over-summering hosts for wheat curl mites and associated viruses

Wheat is grown on more land than any other crop around the world and it is the mainstay of dryland cropping systems in the western Great Plains. The wheat-mite-virus complex is the second largest cause of disease loss in winter wheat production in this region. This complex consists of three viruses, *Wheat streak mosaic*, *Wheat mosaic*, and *Triticum mosaic virus*. All of these viruses are transmitted by the wheat curl mite. Widespread outbreaks of this virus complex are often linked to pre-harvest volunteer wheat. However, situations have occurred where management tactics were not conducive to volunteer wheat and significant losses of winter wheat still occurred, indicating that other grass species may serve as a host for wheat-mite-virus complex.

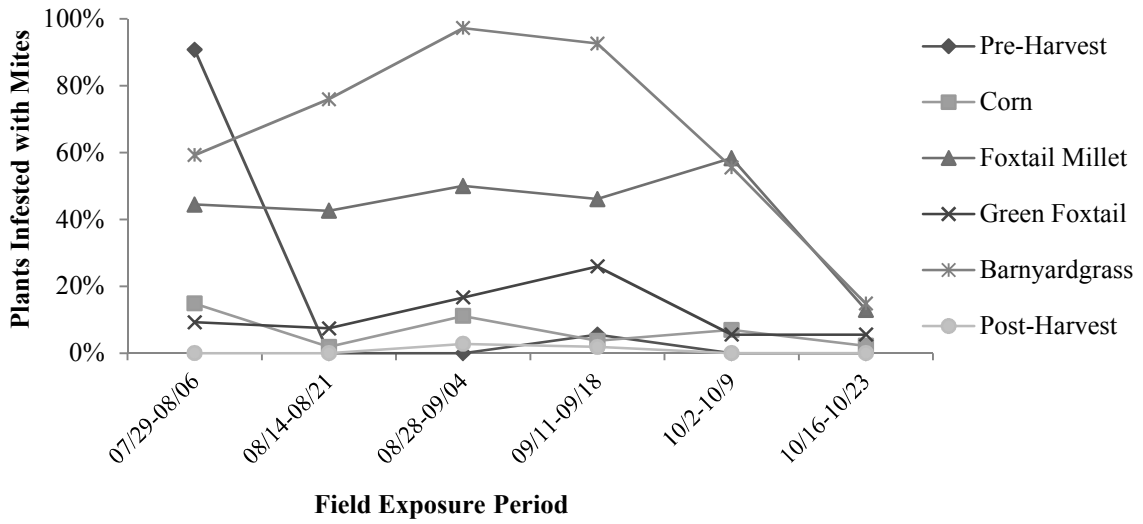
A study was conducted to determine the potential for wheat curl mites to survive on alternative hosts during the summer under field condition and the impact that these hosts have as potential sources for mites and virus transferring to fall planted winter wheat. Five hosts were used in this study. The primary host (pre-harvest and post-harvest volunteer wheat) and secondary hosts (corn, foxtail millet, barnyardgrass, and green foxtail) were seeded in small plots in a randomized complete block design with six replications. With the exception of post-harvest volunteer wheat, hosts emerged prior to winter wheat harvest. Post-harvest wheat was planted one week after the destruction of pre-harvest wheat (two-weeks after winter wheat harvest).

To monitor mite movement within the plots, four trap pots were placed around the study. Trap pots consisted of three cone-tainers with each cone-tainer containing three wheat plants grown in plastic cylindrical cages for 14-days under artificial lights. Cages were removed and plants were then exposed to the field for one-week intervals. After seven days of exposure, plants were cut at soil level, placed in plastic bags, and mites were counted. One week after winter wheat harvest, trap pots were placed in the center of each plot. These trap pot plants were collected after a one-week exposure and new plants were added every two weeks. The plant stage of each plot was determined during each trap pot collection. During peak mite movement periods, four cone-tainers (three plants/cone-tainer) were placed in each trap pot. Plants from two cone-tainers were inspected for mites, and the other half were reared in cages for an additional month after field exposure and tested for virus presence via ELISA. Winter wheat was seeded around the plots in the fall to determine virus spread potential the following spring.

Figure 1 shows that there are significant differences between hosts for mite presence throughout the summer, with the highest mite presence occurring in barnyardgrass plots followed by foxtail millet. Pre-harvest volunteer wheat plots were heavily infested with mites (91% infested) one-week after harvest and were destroyed to reduce the likelihood for contamination of other treatments. In contrast, post-harvest volunteer had very low mite presence throughout

the summer with mites with highest mite presence (3%) occurring on 11-Sept to 18-Sept. The difference in mite presence between pre-harvest and post-harvest volunteer wheat indicates the importance of risk for this complex relative to when volunteer wheat emerges with wheat emerging prior to harvest having the highest risk. Virus presence assays on trap pots during peak mite movement periods (Aug 28 – Sept 4, 2013 and Oct 2 – Oct 9, 2013) showed a significantly higher presence of the virus in barnyardgrass with 11 of 12 and 7 of 12 cone-tainers testing positive for WSMV, respectively. Only 3 of 12 Foxtail millet cone-tainers tested positive in the early sample period. No positive samples were found for all other hosts and either time period. Additional sampling will be done during the spring of 2014 to determine mite spread and virus impact from treatments.

Figure 1. Average percentage of trap plants infested with mites after one-week exposure every other week from late July to late October.



Window of risk for volunteer wheat establishment during the heading stages of wheat and the potential for wheat curl mite infestation

Widespread outbreaks of wheat curl mites and the viruses they transmit (*Wheat streak mosaic, Wheat mosaic,* and *Triticum mosaic virus*) are often linked to volunteer wheat arising after hail that occurs prior to harvest. A study was conducted to determine the wheat head development stages when wheat was able to germinate and the potential for wheat curl mites to colonize this volunteer wheat. Wheat heads were collected from four varieties (‘Camelot’, ‘Mace’, ‘Millennium’, and ‘Pronghorn’) during two separate growing seasons at each of two University of Nebraska Winter Wheat Variety Trial locations (2011-12, Cheyenne and Deuel counties; 2012-13, Cheyenne and Kimball counties). Five heads were collected from each of the five plots (reps) for the four varieties every five to seven days during head development. Three of the five wheat heads were staged individually, and placed on sterilized greenhouse soil in separate containers. After 21 days, wheat heads were evaluated for germination, plant height and mite presence. The remaining two heads were placed on high definition tape and later counted to determine total mite presence.

Results indicate that wheat can germinate during the early milk stage and that germination potential increases after this stage (Fig. 2). Mite counts on tape indicated significant differences between locations for each year of the study with the greatest mite numbers occurring at Deuel County in 2011-12. Mites were able to directly colonize the germinating wheat plants during the later heading stages (i.e. after early dough stage) with higher infestations occurring at locations with the highest density of mites per head.

A field study was conducted using a hail machine to verify the germination and mite presence results from wheat head collection study. Treatments were arranged in a split-plot, randomized complete block design with six replications. The main plot treatments were varieties, and split-plot treatments were hail dates. Varieties were chosen based on their tolerance to pre-harvest germination; Camelot (tolerant) and Pronghorn (susceptible). These varieties were hailed on three different dates based on wheat head stage; late milk/early dough (HD1), soft dough (HD2), and hard dough (HD3). Germination per row foot of winter wheat was collected from each plot every seven days up to 21 days after the hail event. Volunteer wheat was sampled from each plot approximately two-weeks prior to fall planting to determine mite presence.

Results show a significant impact of variety and hail date on volunteer establishment with the highest germination occurring with Pronghorn wheat at hard dough. The germination of volunteer wheat was heavily influenced by environmental conditions with significant germination occurring after heavy rain. Mite presence on volunteer wheat was highest in HD3 (23%) followed by HD2 (15%) and HD1 (8%). Mite presence data suggest that higher WCM population densities in wheat heads increases the likelihood that WCM will infest volunteer wheat directly from the seed. Variety tolerance to pre-harvest germination was similar for the wheat head collections and field study. However, germination under field conditions was highly influenced by environmental conditions.

Figure 2. Percent germination for individual wheat heads for four varieties for all stages of head development over 21 days (2011-12 and 2012-13).

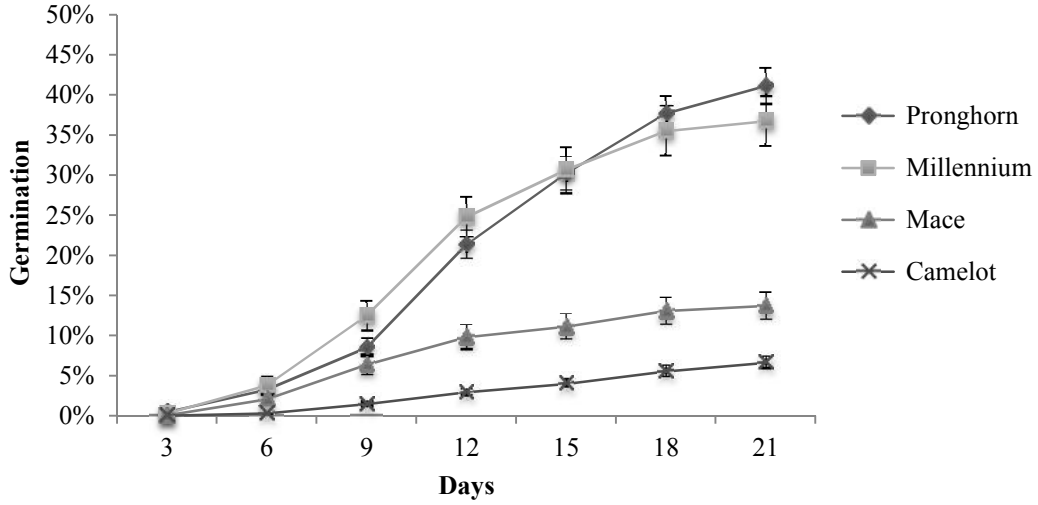
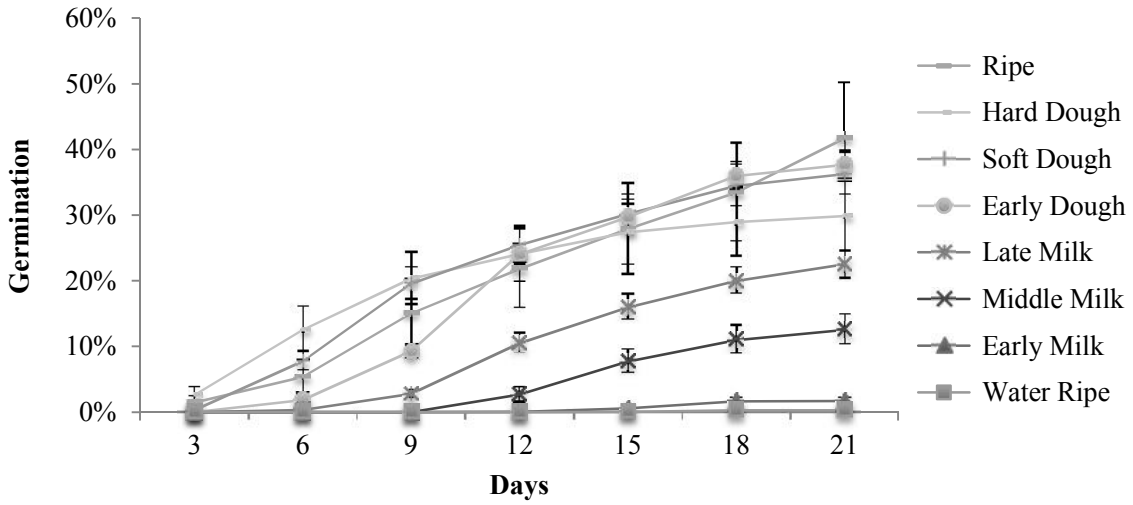


Figure 3. Percent germination for individual wheat heads for the eight stages of head development across all four varieties of wheat over 21 days (2011-12 and 2012-13).



Impact of simulated rainfall on wheat curl mite populations in headed wheat

Mite movement is critical to the spread of these viruses and their potential to cause widespread yield losses. Previous studies have indicated that secondary spread of mites increases as the mite population density increases. Rainfall was considered to have a poor correlation with mite movement; however, no studies have used sampling techniques that adequately test the impact of rainfall on mite movement. To determine the impact of rainfall on mite populations a simulated rainfall machine was used on an existing wheat field at the High Plains Agricultural Lab near Sidney, Nebraska. Treatments (no rain, rain at soft dough (Z85), rain at hard dough (Z87), rain at soft and hard dough (Z85+87)) were arranged as a randomized complete block with six replications. A rainfall machine was calibrated prior to field application to apply ¾ inch of rain in 8 minutes at 6 psi. Three of the six random reps were artificially infested with mites to ensure adequate mite presence in wheat heads prior to rainfall application. To infest heads, infested tillers were harvested from a nearby volunteer wheat field and cut into ½ inch section and fastened to 25 wheat heads in each plot with paper clips and tagged with tape. Five wheat heads were taken from each plot once heading occurs and four collection periods were made during the season. The development stage of each individual wheat head was determined, and then placed on high definition tape to determine mite populations.

Results indicate that the greatest mite densities per head occurred under soft dough rainfall application. Means for each sample date were nearly identical for natural rainfall and double application. Lowest mite populations were observed in hard dough application but only for the 3rd sample data. Trends in mite populations were similar for infested and uninfested plots; however, mean mite populations were greater in the 3rd sample date. Preliminary results indicate that rainfall had little impact on mite populations. Further studies are needed to confirm these results and establish if these results are consistent across various rainfall levels.

Survey of weeds in winter wheat stubble in the western Great Plains

Fifteen counties across the Nebraska Panhandle, northeastern Colorado, and northwestern Kansas were surveyed with a minimum of three fields per county. Crop rotation, stubble height, tillage practices, and weed species densities were recorded for each field. The size of the sample area for each field was based on the weed density. Counts for a single weed species were recorded for ¼ m^2 when populations were greater than 50 plants within that area. If fewer than 50 plants were found within ¼ m^2, counts were made up to ½ m^2 and stopped if densities were greater than 50 plants. One-meter area counts were made on all species with lower densities. A total of ten random samples were taken from each field. The height and type of weeds were recorded at each site within the field. Fields were sampled during mid-August when weeds are fully developed to allow for accurate weed identification. Unknown weeds were photographed, numbered, sampled, and placed in a miscellaneous category. Results indicate that volunteer wheat, stinkgrass, Russian thistle, green foxtail, and redroot pigweed had the highest frequency in winter wheat stubble.

Impact of resistant varieties and planting dates on virus development and expression across region environmental conditions

This study will be conducted at HPAL and across the region with additional sites in Montana and Texas. The focus will be to establish demonstration and research plots with consistent treatments across the region to enable us to compare the impact of environmental conditions on subsequent mite and disease incidence and severity in resistant and susceptible cultivars. This study will incorporate variable planting dates that are representative of early, recommended and late planting dates for each location. The study will be a randomized split plot design with six replications with main plot treatments being three dates of planting. The early dates will be in late August for all locations. The middle planting dates will correspond to the recommended planting date for the location, and the late planting date will be 2-3 weeks after the middle date, except in Texas where the late planting date will be in early to mid October. At HPAL, subplots will be five cultivars, including Mace (*wsm*1), Snowmass (*wsm*2), Tam 112 (virus, mite and drought-tolerant), Pronghorn and Settler CL.

During the summer prior to planting, simulated volunteer wheat will be planted around the plot area before harvest to establish a mite-virus trap area. These areas will be maintained through the summer to provide mites and virus to infest plots planted in the fall. Weather conditions will be monitored throughout the year. Mite density and virus presence will be verified in the volunteer (trap) wheat and the fall planted wheat varieties later in the fall. Through the growing season, plots will be monitored for the development of viral symptoms by measuring relative chlorophyll and visual ratings. Virus species will be identified and quantified by ELISA or qPCR (Price *et al*. 2010). Yield and grain quality will be determined at wheat maturity.

Water Use and Crop Productivity of Perennial Grasses under Limited to Full Irrigation in a Semi-Arid Climate

Gary W. Hergert, James Margheim, Alexander Pavlista, Karla H. Jenkins,
Rex Nielsen, Gary Stone and Murali Darapuneni

Introduction

Future ethanol production above the Energy Independence and Security Act/Renewable Fuels Standard (EISA/RFS) cap of 15 billion gallons in 2015 will require new biofuel materials. The High Plains is a short grass prairie ecosystem that supports both cool season (CS) and warm season (WS) native species. Many producers in western Nebraska face reduced irrigation amounts due to drought (reservoir water) and NRD ground water allocations. The research objectives of this project were to: 1) determine the production of perennial cool- and warm-season forages (monoculture vs mixes) from dryland to fully irrigated conditions in a semi-arid climate and 2) determine yield-ET relationships plus irrigation effects on seasonal distribution of forage production, quality and plant growth.

Materials and Methods

Plots were established in 2009 on a Tripp fine sandy loam soil at the Scotts Bluff Ag Lab (SBAL), Scottsbluff, NE ($41^0$50'N, $103^0$41'W, elevation 3,962 ft) and on a Keith silt loam at the High Plains Ag Lab (HPAL), Sidney, NE ($41^0$22'N, $103^0$1'W, elevation 4,320 ft). After 2010, neutron probe depths and irrigation levels were adjusted to improve neutron measurements and irrigation scheduling; therefore, results are presented only for the study years of 2011-2013.

Differential treatments, targeting 0,5,10 and 15 inches of cumulative irrigation, were applied to CS and WS grasses, under linear irrigation systems, and replicated three (3) times in a randomized complete block design. Cool-season grass plantings were: CS-1) orchard grass (cv Extend); CS-2) mix of western (cv Barton), intermediate (cv Beefmaker) and pubescent (cv Manska) wheatgrasses and CS-3) mix of meadow (cv Regar) and smooth (cv VNS) bromegrasses, creeping foxtail (cv Garrison) and orchard grass. Warm-season grass plantings were: WS-4) switchgrass (cv Trailblazer); WS-5) mix of big bluestem (cv Bonanza) and Indian grass (cv Holt); and WS-6) mix of switchgrass, big bluestem and Indian grass.

Irrigation scheduling was based on estimated crop use and/or critical growth stages. Rain gauges were placed within plot areas to accurately record irrigation and rainfall amounts. Soil water contents were determined weekly with a neutron probe at soil depths of 1,2, 3, and 4 feet during the growing season. Cumulative water use (ET) was calculated from the water balance equation and assumed negligible rainfall and irrigation loss by deep percolation and runoff. However, observed runoff losses, resulting from significant/intense rainfall events were estimated from differences in neutron probe readings taken prior to and after such events.

Nitrogen fertilizer rates, for the various irrigation treatments, were based on dry matter and Nitrogen relationships from published dryland and full-ET research data. Glyphosate was

used for weed control during dormancy periods for both CS and WS grasses, while atrazine 4L was applied at the rate of 0.50-0.75 qt/ac (early spring) for additional weed control in WS plots.

Plots were harvested with a tractor-mounted, flail-type chopper (5 ft cutting width), to which was attached a custom-built dump container and electronic weighing system. Subsamples from each plot were collected to determine moisture, from which total dry matter was determined.

Results and Discussion

The crop productivity functions for CS and WS perennial grasses at SBAL and HPAL are presented in Figures 1-2 and 3-4, respectively. All of the functions show that a certain amount of water use is required before the production of any forage yield is expected (intercept of regression line with cumulative water use axis). The amount of this required water is referred to as the "threshold water use" (TWU) and can vary, to some degree, on factors such as the proportion of water use from the soil and vegetative evaporation and climatic conditions (i.e. humidity).

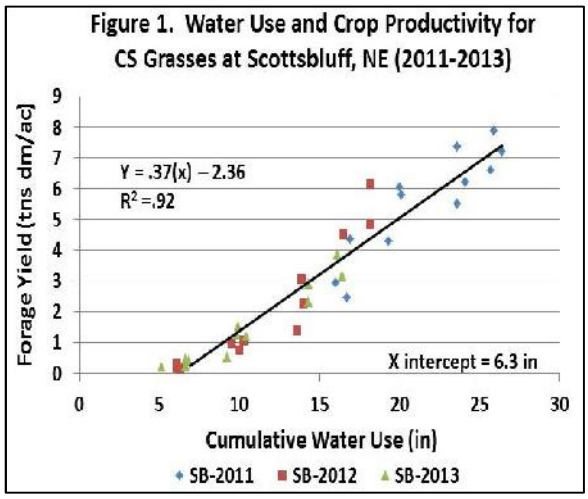
Warm-season grasses had a lower TWU than CS grasses at both study sites. At SBAL and HPAL, the data indicate TWU values for CS grasses of 6.3 and 6.1 inches, respectively, while comparative TWU values for WS grasses were 4.8 and 2.8 inches, respectively. In comparison to SBAL, it is worth noting that the lower TWU for WS grasses at HPAL may be a reflection of decreased yields, particularly at higher water use values, the result of which was due to late frosts (May 20 and May 29) and the loss of irrigation water during a critical irrigation period (June 7-20). The lower TWU for WS grasses at both locations, in comparison to CS grasses, may be indicative of faster canopy closure and less evaporative soil water loss during the regrowth period(s).

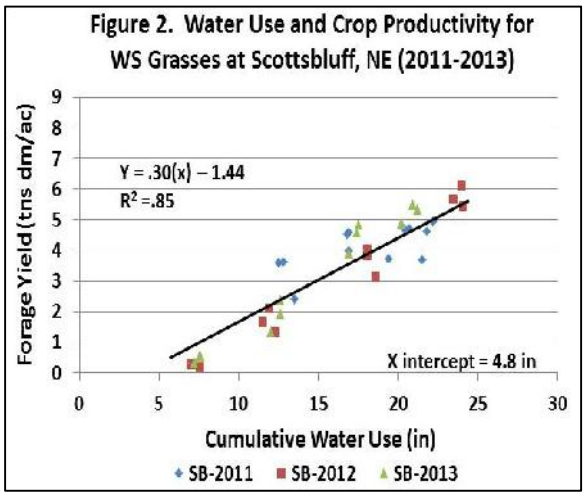
The slopes of the linear regressions in Figures 1-4 are a measure of "water productivity" or "water use efficiency". The slopes represent the yield increase per additional unit of water use beyond the yield threshold water use. Crop water productivity can be affected by factors such as harvest index, inherent crop productivity and various climatic conditions.

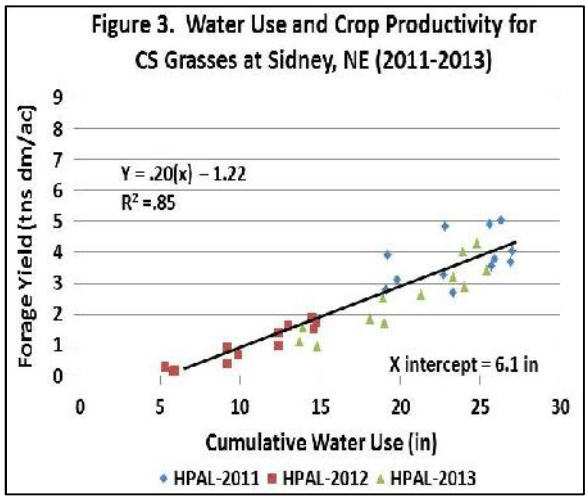
At SBAL (Figures 1-2), the water productivity of CS and WS grasses was determined to be 0.37 tons dry matter/ac per inch (740 lbs dry matter/ac per inch) and 0.30 tons dry matter/acre per inch (600 lbs dm/ac/in), respectively. The SBAL yield of CS grasses was more responsive to additional amounts of water from irrigation than were WS grasses. However, due to the lower TWU value for WS grasses, the productivity function also indicates that WS grasses at SBAL may have a yield advantage under drought conditions when cumulative water use is below approximately 13-14 inches.

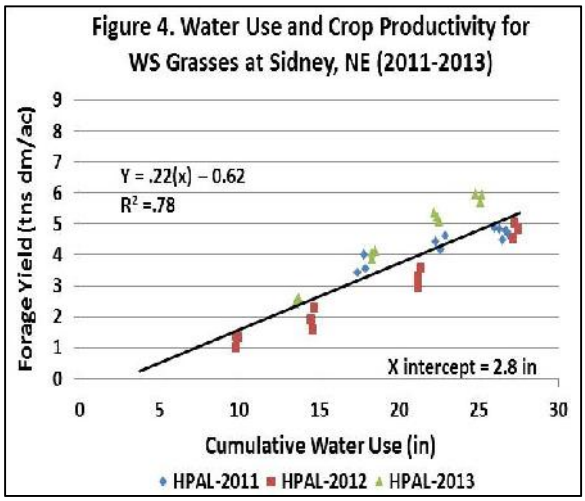
For each additional inch of cumulative water use at HPAL (beyond TWU), forage yields increased 0.20 tons dry matter/ac (400 lbs dry matter/ac) and 0.22 tons dry matter/ac (440 lbs dry matter/ac) for CS and WS grasses, respectively. In contrast to SBAL, these water use efficiencies suggest that yields of WS grasses at HPAL were more responsive to additional amounts of water than CS grasses over the entire range of water use values.

Although the productivity functions do not describe a point of diminishing yield for increases in evapotranspiration demands greater than full-ET, this point is thought be near or at water use amounts associated with maximum yields. Maximum yields for CS and WS grasses, for all location years, occurred at cumulative water use values of approximately 25.9 and 24.0 inches, respectively. Tables 1 and 2 present a summary of maximum yields for CS and WS grasses at both study sites.









At SBAL (Table 1), the maximum yield for CS grasses (5.06 tons dry matter/ac) and WS grasses (5.16 tons dry matter/ac) were not significantly different when averaged over study years (2011-13). The highest yielding WS grass was WS-6 (mix of switchgrass, big bluestem and Indian grass), with an average yield of 5.51 tons dry matter/ac; however, there was no significant difference in the averages of maximum yields for any of the WS grasses. The highest yielding CS grasses were CS-2 (wheatgrass mixture) and CS-3 (bromegrass mixture), with average maximum forage yields of 5.98 and 5.08 tons dry matter/ac, respectively. In 2011, the CS-2 and CS-3 grass mixtures yielded 7.91 and 7.24 tons dry matter/ac, respectively, which were the highest yields observed during the study. The average maximum yield of CS-2 was significantly

higher than that of CS-1 (orchard grass). Factors responsible for significant reductions in maximum yields of orchard grass, in comparison to other CS grasses, are thought to include: 1) limited vegetative growth during high ET conditions and 2) decreased winter survival associated with limited irrigation treatments.

Table 1. Maximum Yields of CS and WS Grasses at Scottsbluff, NE (2011-2013)

Year	CS Grass Yields (tons dm/ac)			WS Grass Yields (tons dm/ac)		
	CS-1	CS-2	CS-3	WS-4	WS-5	WS-6
2011	6.62	7.91	7.24	4.70	3.97	4.94
2012	4.51	6.13	4.81	5.65	5.44	6.09
2013	1.21	3.89	3.18	4.87	5.33	5.50
Ave	4.11	5.98	5.08	5.07	4.91	5.51

CS-1 = orchard grass; CS-2= mix of western, intermediate and pubescent wheatgrasses; CS-3 = mix of meadow and smooth bromegrasses; WS-4 = switchgrass; WS-5 = mixture of big bluestem and Indian grasses ; WS-6 = mix of switchgrass, big bluestem and Indian grasses

Table 2. Maximum Yields of CS and WS Grasses at Sidney, NE (2011-2013)

Year	CS Grass Yields (tons dm/ac)			WS Grass Yields (tons dm/ac)		
	CS-1	CS-2	CS-3	WS-4	WS-5	WS-6
2011	3.71	5.05	4.06	4.87	4.74	4.78
2012	1.52	1.74	1.85	5.02	4.83	4.54
2013	3.22	4.30	3.44	5.97	5.71	5.95
Ave	2.82	3.70	3.12	5.29	5.09	5.09

CS-1 = orchard grass; CS-2= mix of western, intermediate and pubescent wheatgrasses; CS-3 = mix of meadow and smooth bromegrasses; WS-4 = switchgrass; WS-5 = mixture of big bluestem and Indian grasses ; WS-6 = mix of switchgrass, big bluestem and Indian grasses

At HPAL (Table 2), the maximum yield for CS grasses (3.21 tons dry matter/ac) was significantly lower than the maximum yield (5.16 tons dry matter/ac) for WS grasses when averaged over study years (2011-13), a result of which is primarily due to adverse growing conditions during the spring of 2012. There was no significant difference between averages of maximum yields for WS or CS grasses. Switchgrass (WS-4) had the highest average maximum yield (5.29 tons dry matter/ac) and highest annual yield (5.97 tons dry matter/ac, 2013) for CS or WS grasses. Wheatgrass mixture (CS-2) had both the highest average maximum yield (3.70 tons dry matter/ac) and annual yield (5.05 tons dry matter/ac, 2011) for CS grasses.

Summary

At SBAL, there was no significant difference in the maximum yields of CS and WS grasses when averaged over study years (2011-13). Crop production functions indicate a water productivity of 0.37 and 0.30 tons dry matter/acre per inch for CS and WS grasses, respectively. Highest yields for CS and WS grasses were observed to be 7.91 tons dry matter/ac (2011) and 6.09 tons dry matter/ac (2012), respectively. Productivity functions predict a maximum yield advantage of approximately 15% for CS grasses, compared to WS grasses, at cumulative water use values at or near full ET crop demand (24-26 inches); however, WS grasses may be more responsive to drought conditions when total water use is less than 13-14 inches.

At HPAL, the maximum yield for CS grasses (3.21 tons dry matter/ac) was significantly lower than for WS grasses (5.16 tons dry matter/ac) when averaged over study years (2011-13). The water productivity of WS grasses (0.22 tons dry matter/ac per inch) was marginally more responsive to additional amounts of water than CS grasses (0.20 tons dry matter/ac per inch) over the entire range of cumulative water use values. Highest yields for CS and WS grasses were 5.05 tons dry matter/ac (2011) and 5.97 tons dry matter/ac (2013), respectively. At cumulative water use values at or near full ET crop demand, productivity functions predict a maximum yield advantage of about 25% for WS grasses compared to CS grasses. Under drought and/or limited irrigation conditions, the data also suggest that WS grasses are more responsive to additional water use than CS grasses.

Conclusions

Productivity functions can be used to evaluate and compare the yield, water use and water productivity ("water use efficiency") of various crops over a range of applied irrigations. During this study, maximum yields of CS and WS grasses were observed to be 7.91 and 6.09 tons dry matter/ac, with total water use values of 25.9 and 24.0 inches and "water use efficiencies" of 0.37 and 0.30 tons of dry matter/ac per inch, respectively. The data indicate that, with "normal" climatic and edaphic growing conditions, maximum biomass production of perennial grasses will require 10-12 inches of irrigation in the semi-arid Nebraska Panhandle.

Annual Forages Following Irrigated Winter Wheat

Karla H. Jenkins, Aaron Berger, Gary Hergert, Gary Stone, Rob Higgins, and Jim Margheim

Introduction

Western Nebraska is a low rainfall area with annual rainfall ranging from 8 to 18 inches per year. Precipitation usually occurs in the early spring benefitting the predominately cool season grass species mix in High Plains pastures. Unfortunately, limited summer rainfall and declining quality of cool season pastures creates a challenge for producers needing a forage resource in the fall. Planting forages after irrigated winter wheat may allow producers to use a limited amount of water to produce additional forage for fall or winter grazing, or for baling as hay. The objective of this research was to evaluate three annual forages with two planting dates and two water levels to evaluate dry matter production, digestibility (TDN), and crude protein (CP) for beef cattle.

Methods and Materials

2012

Two summer annuals (sorghum sudangrass (BMR) and White Wonder foxtail millet), and one cool season annual (oats), were planted at 25, 15, and 100 lb/ac., respectively, following irrigated winter wheat harvest in 2012. In 2012 wheat harvest was early due to the extreme heat and drought and forages were planted on July 18th, and August 2nd. Fertilizer was broadcast supplying 50 lb. N/acre. Water was applied at two irrigation levels, 4" and 8". Initially, the plan was to use 3" and 6" but the extreme drought conditions warranted higher levels of irrigation. Plots were harvested on September 26, 2012 for dry matter production. Subsamples of each plot were analyzed for crude protein (CP), total digestible nutrients (TDN), and NO_3-N. A subset of each plot was left standing throughout the winter and was subsampled again on March 5, 2013 and analyzed for CP, TDN, and NO_3-N.

2013

Sorghum sudangrass, foxtail millet, and oats were planted at the same rate as in 2012, but in 2013, irrigated winter wheat was harvested in late July, and therefore, the planting dates were August 5, and 20, 2013. Additionally, Roundup Ultramax was applied to the whole plot area (32 oz/ac) on July 27, 2013 and again to the second planting date plots on August 22, 2013. Sixty lb. of N per acre was also applied on August 22, 2013. To be consistent with 2012, 4" and 8" of irrigation were to be applied. However, due to irrigation system issues and above normal rainfall in September (8 inches), only 4" and 5" were applied. The plots were harvested on October 8, 2013 for dry matter, CP, TDN, and NO_3-N. Subsamples were left standing for subsequent analysis after the winter.

Results and Discussion

2012

The earlier planting date was advantageous to the dry matter production of the sorghum sudangrass but was not significantly different for the oats or foxtail millet ($P < 0.05$; Table 1). The 8" irrigation level significantly improved dry matter production for all three forages ($P < 0.05$; Table 1). The CP and TDN were not affected by water level within forage. However, CP and TDN were greater within each forage, for the later planting date which was simply a function of less plant maturity. All forages, regardless of planting date or water level, had a CP value of 16-20% and a TDN level of 62-68%which would be considered a medium quality feed source for beef cattle (Table 2). The NO3-N levels were high (Table 3) (> 1500 ppm is considered unsafe for feeding even non-pregnant animals unless mixed with low nitrate feed to dilute the ppm to 1500 ppm or less.) due to the drought conditions and immaturity of the forage at harvest.

Results from the subsamples taken in March indicated the CP% was 11-13% which is adequate to maintain rumen function (Table 3). The %TDN was only slightly lower than the September harvest date indicating all three forages made an acceptable option for standing forage through the winter. The NO3-N values by March were below 1500 ppm. Therefore, nitrate toxicity while grazing the forages as standing hay in the winter would not have been an issue.

2013

The tonnage, regardless of planting date and water level was similar for the sudangrass and oats, but less (Table 4; $P < 0.01$) for the foxtail millet. Overall, crude protein and TDN were greater for the oats and foxtail millet compared to the sudangrass (Table 4; $P < 0.05$).Water level did not impact production within forage type. The earlier planting date resulted in greater dry matter yield for all crops compared to the later planting date. The earlier planting date resulted in the greatest dry matter yield for oats followed by sudangrass, and then foxtail millet (Table 5; $P < 0.05$). The second planting date resulted in greater CP for all forages, but similar TDN for the sudangrass and foxtail millet (Table 6; $P< 0.05$). The 5" irrigation level resulted in greater TDN for the oats but similar TDN for each of the other two forages. The CP was similar within forage across irrigation treatment. The NO3-N concentration was well below concern, most likely because 8.4 inches of rain was received in September.

Conclusion

Planting annual forages after irrigated winter wheat is harvested may be a beneficial way to utilize land for both crops and livestock. The earlier forages can be planted after wheat harvest, the more dry matter can be produced before frost. The window of opportunity for planting the forages appears to be fairly narrow since forages planted the third week of August produced substantially less dry matter than forages planted by the first week in August. The tradeoff for dry matter production is decrease quality. However, all forages in this two year study resulted in acceptable crude protein and digestibility for beef cattle regardless of dry matter production. Additionally, these forages could be used as standing hay for winter grazing as the quality did not drastically deteriorate throughout the winter.

Table 1. Dry matter tons produced in 2012 for sorghum sudangrass, oats, and foxtail millet harvested 9/26/2012

	Planting Date		Irrigation Level	
	7/18/2012	8/02/2012	4”	8”
	Tons/ac		Tons/ac	
Sorghum Sudangrass[1]	2.5[a]	1.5[b]	1.3[a]	2.7[b]
Oats	1.2[b]	1.3[b]	0.85[c]	1.7[a]
Foxtail Millet	1.3[b]	1.1[b]	0.87[c]	1.5[a]
[1]Means with different superscripts within planting date differ, means with different superscripts within irrigation level differ, $P < 0.05$.				

Table 2. Crude protein and total digestible nutrients for sorghum sudangrass, oats, and foxtail millet harvested 9/26/2012

	Planting Date				Irrigation Level			
	7/18/2012		8/02/2012		4”		8”	
	CP	TDN	CP	TDN	CP	TDN	CP	TDN
Sorghum Sudangrass[1]	10.6[a]	61.8[a]	13.4[c]	64.7[b]	13.5[a]	63.9[ad]	10.6[b]	62.6[a]
Oats	14.2[cd]	65.0[be]	18.3[b]	68.2[cd]	16.3[c]	66.4[cd]	16.2[c]	66.8[bc]
Foxtail Millet	12.9[c]	66.5[bd]	16.0[d]	67.5d[e]	14.4[ac]	68.1[bc]	14.5[ac]	65.9[cd]
[1]Means with different superscripts within planting date differ, means with different superscripts within irrigation level differ, $P < 0.05$.								

Table 3. Crude protein and total digestible nutrients for sorghum sudangrass, oats, and foxtail millet harvested either 9/26/2012 or 3/5/2013

	Harvested 9/26/2012			Harvested 3/5/2013		
	% CP	% TDN	NO_3-N	CP	TDN	NO_3-N, ppm
Sorghum sudangrass[1]	15.9[a]	63.2[a]	3320	12.0[a]	62.5	1283
Oats	20.1[b]	66.6[b]	4276	13.7[b]	64.3	1216
Foxtail Millet	18.3[b]	67.0[b]	2641	11.8[a]	62.9	1195
[1]Means with different superscripts within a column differ ($P < 0.05$).						

Table 4. Overall dry matter yield, crude protein, total digestible nutrients, and nitrate concentration for sorghum sudangrass, oats, and foxtail millet harvested 10/8/2013.

	Ton/ac	% CP	% TDN	NO3-N, ppm
Sorghum sudangrass[1]	1.00[a]	11.6[a]	61.8[a]	277
Oats	1.09[a]	15.0[b]	67.8[b]	91
Foxtail Millet	0.64[b]	16.4[b]	65.5[b]	314
[1]Means with different superscripts within a column differ ($P < 0.05$).				

Table 5. Dry matter tons produced in 2013 for sorghum sudangrass, oats, and foxtail millet harvested 10/8/13

	Planting Date		Irrigation Level	
	8/05/2013	8/20/2013	4”	5”
	Tons/ac		Tons/ac	
Sorghum Sudangrass[1]	1.22[a]	0.77[d]	1.04[a]	0.95[a]
Oats	1.54[b]	0.65[d]	1.12[a]	1.06[a]
Foxtail Millet	1.00[c]	0.27[e]	0.66[b]	0.61[b]
[1]Means with different superscripts within planting date differ, means with different superscripts within irrigation level differ, $P < 0.05$.				

Table 6. Crude protein and total digestible nutrients for sorghum sudangrass, oats, and foxtail millet harvested 9/26/2012

	Planting Date				Irrigation Level			
	8/05/2013		8/20/2013		4”		5”	
	CP	TDN	CP	TDN	CP	TDN	CP	TDN
Sorghum Sudangrass[1]	10.1[a]	60.3[a]	13.2[bd]	63.3[ab]	10.9[a]	60.6[a]	12.3[a]	63.0[ab]
Oats	11.1[ad]	65.8[b]	19.0[c]	69.9[c]	14.8[b]	64.2[ab]	15.2[bc]	71.5[c]
Foxtail Millet	13.5[b]	63.9[b]	19.2[c]	67.2[bc]	15.6[bc]	65.1[b]	17.2[c]	66.0[b]
[1]Means with different superscripts within planting date differ, means with different superscripts within irrigation level differ, $P < 0.05$.								

Fenugreek Yield as Affected by Planting Date and Irrigation

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Project Purpose

Fenugreek is an annual legume which has been known for millennia for its medicinal properties, e.g., treating Type 2 diabetes. Today, 75% of the world fenugreek production is in north central plains of India and there is no production in the USA or even in the Western Hemisphere. Scientific literature from India suggests that fenugreek would do well in light (sandy, sandy loam) and alkaline soil (pH 8-8.5). Both of these conditions characterize the Nebraska Panhandle. Furthermore, the Indian literature states that fenugreek requires less N than many crops (about 60 lb/a) and does well under low rainfall (12-15 inches). The relatively low precipitation requirement suggest suitability for the semi-arid Nebraska Panhandle. The only published research in North America on fenugreek is from Alberta, Canada, and the studies were only a few years ago. There, researchers developed the only North American cultivars of fenugreek, e.g., Tristar and Amber. They are shorter season, 120 day, cultivars as opposed to those used in India and therefore better suited for our shorter season. When production parameters for fenugreek are identified and cultivars are developed with high medicinal quality for western Nebraska, we will have the base for a potential new and highly profitable industry in this state. Production and breeding research are both needed for success.

Methodology

Fenugreek varieties Amber and Tristar were on May 6, May 17 and May 28, 2013. Planting, cultivating and herbicide applications went according to schedule. Soil nitrogen in top 16 inches indicated a sufficient level for fenugreek production. After each planting, 0.25 inch of irrigation was added to promote emergence and incorporate the pre-emergence herbicide (trifluralin). A post-emergence herbicide, imazamox, was applied within two weeks after emergence. Irrigation treatments, full, half, and none, began on June 10. Irrigation for full treatment was 0.5 inch applied twice a week and half treatment was 0.5 inch applied once a week. The target totals for full irrigation were 12 inches during the growing season depending on harvest date. Rainfall was monitored daily but not used to adjust irrigation. Depending on planting to harvest dates, rainfall ranged from 3 to 8 inches during the growing season. Sub-sections of each plot were hand-harvested on 20 Aug (first harvest), 10 Sep (second harvest) and 2 Oct (third harvest). Growth patterns, plant height and weight, and flowering and fruiting, as influenced by planting date and irrigation level were measured from June 5 to Sept 4.

Results and Conclusions

Both fenugreek varieties, Amber and Tristar, behaved much the same way.Although planting later in May delayed the onset of growth, the vines of later planting dates grew faster and all plants regardless of planting date were the same height by 17 July regardless of irrigation level. After that date, height was affected by amount of irrigation and increased gradually (data not shown). Maximum plant weight was achieved with the third planting for both varieties and

irrigation was required. However, the two varieties differed substantially (data not shown). Flowering dates for both varieties were delayed by one week for each delay in planting. Full bloom occurred on 26 June, 3 July and 10 July for planting on 6, 17, and 28 May, respectively. Pod set peaked about a week after full bloom. Irrigation level had no effect on date of flowering or fruiting.

Yield was affected by planting date, harvest date and irrigation level. The two varieties did not differ significantly; therefore, Tristar is reported here. Maximum yield, greater than 1500 lb/a, was achieved at the Aug harvest only by fully irrigated (1 inch / week) plots planted 17 or 28 May (Figure 1). At the later harvest in Sep, maximum yield was achieved also at half irrigation (0.5 inch / week) but only with the third planting, 28 May (Figure 2). The results indicated: 1. If harvesting is planned in Aug, then planting may be in mid- or late-May but full irrigation must be applied to achieve yield potential. 2. If irrigation is limited to half, then to achieve yield potential, fenugreek must be plant at the end of May, maybe early June, and harvested by mid-Sep. Yields under all conditions were substantially reduced to about 500 lb/a when harvest was delayed until early Oct (data not shown).

Acknowledgments

This project is being funded under Specialty Crop Block Grant of the USDA. Appreciation is extended to Les Kampbell and Todd Wilson for their technical assistance.

Figure 1. Tristar Seed Yield Harvested in mid-late Aug, 2013

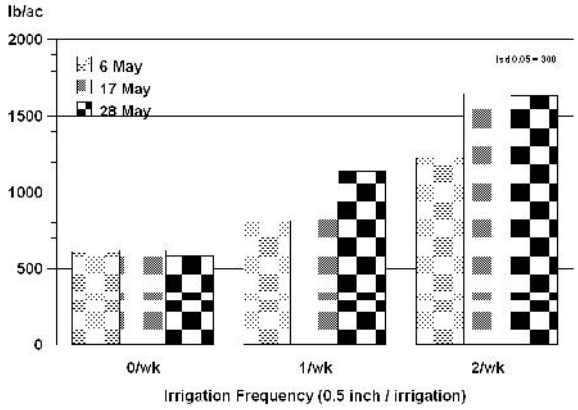
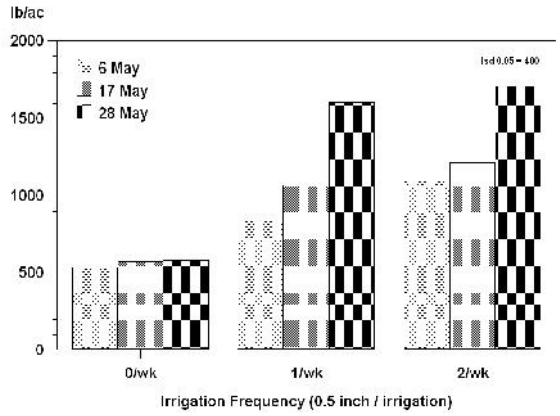
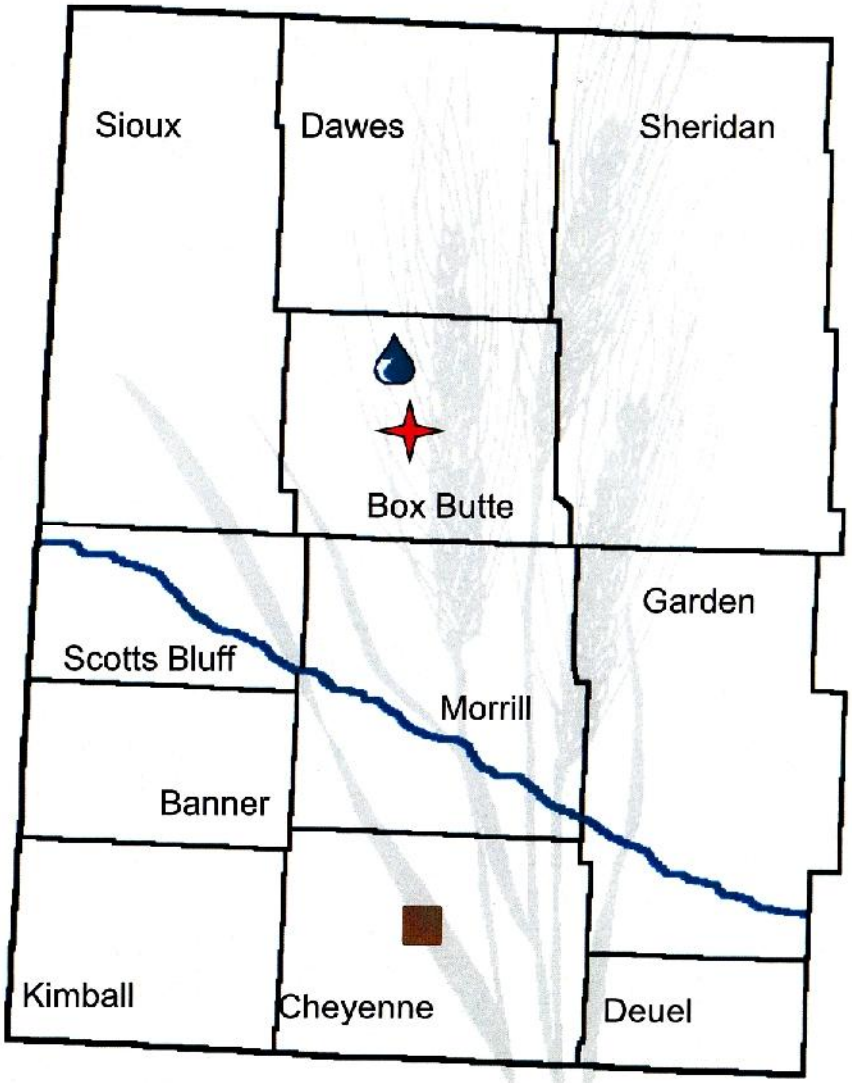


Figure 2. Tristar Seed Yield Harvested in early-mid Sep, 2013



2013 Wheat Plot Tours In Panhandle



June 25 (Tues) 9:00 a.m. High Plains Ag Lab

TO HIGH PLAINS AG LAB SHOP: On Highway 385, 6 miles North of Sidney or 7 miles South of Gurley to Huntsman Elevator; 2.5 miles West on Rd. 32, 0.5 miles North on Rd. 109, 1 mile East on Rd. 32N. Plots are about 0.75 miles Northeast of HPAL shop (Field #13).

9:00 am: Dryland wheat trial*

****There will be pea variety trial tour following wheat plot tour if anyone is interested.***

June 25 (Tues) 3:00 p.m. Box Butte Co. Irrigated

FROM HEMINGFORD: 1.3 miles North of Hemingford on Box Butte Ave, East side of Highway.

June 25 (Tues) 5:00 p.m. Box Butte Co. Dryland

FROM HEMINGFORD: About 5.5 miles South on Highway 2, 0.6 miles West on Hall Rd. Plots are on South side of road (this is 0.5 West of Hall Rd & Rd 67).

Call Dipak Santra at 308-632-1244 OR Vernon Florke (308-249-3161) for more information

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High Plains Ag Lab Field Day

Tuesday, Aug. 6, 2013, Sidney, NE

8:00 **Registration and Refreshments** - Compliments of Scoular Grain Co.

8:15 **Welcome and Administrative Update**

- **Mr. Keith Rexroth**, Chair, High Plains Ag. Lab Advisory Board
- **Thomas Nightingale**, Farm Manager, High Plains Ag. Lab
- **Gary Hergert**, Interim Director, Panhandle Research & Extension Center

8:45 **Research Plot Tour**

- **Proso millet breeding** - Dipak Santra (15 min)
- **Wheat stem sawfly - pest status, pheromone traps, and plant resistance** - Jeff Bradshaw (15 min)
- **Improving our ability to predict risk of viruses in wheat** - Justin McMechan (15 min)

10:00 **Break** - Compliments of Wheat Belt Public Power District

10:15 **Research Plot Tour, continued**

- **Testing fenugreek and pea varieties** - Dipak Santra (15 min)
- **Cover crop cocktails & water use** - David Nielsen (15 min)
- **Forage options behind irrigated wheat** - Aaron Berger (15 min)
- **Perennial grass forage production** - Jim Margheim (15 min)

11:30: **Ground breaking ceremony** for New HPAL Building

Noon Lunch at Shop and Adjourn

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