Publication No. PHREC 16-30

High Plains Ag Lab

Update of Research Conducted in 2015

February 18, 2016

University of Nebraska
High Plains Agricultural Lab
Sidney, Nebraska

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High Plains Ag. Lab. Advisory Committee Annual Meeting
February, 18, 2016 at 9:00 AM to 4:00 PM
Sidney campus of the Western Nebraska Community College

AGENDA

Administrative Updates

09:00 AM: Welcome by Keith Rexroth, HPAL Advisory Board Chair *(10 mins)*

09:10 AM: HPAL update by Dr. Jack Whittier, Director, Panhandle Res. & Extn Center *(20 mins)*

- Faculty position update
- HPAL Future Development

HPAL Research Updates

09:30 AM: HPAL operations, *Rob Higgins, Farm Manger, HPAL (15 mins)*

09:45 AM: Grain Sorghum Variety Trial at High Plains Ag. Lab, *Dr. Cody Creech (10 mins)*

09:55 AM: 2015 Herbicide Evaluations at HPAL in Field Peas and Two-gene Clearfield Winter, *Dr. Cody Creech* and *Rob Higgin (20 mins)*

10:15 AM: Evaluating the Feeding Value of Field Peas for Growing and Finishing cattle in Western Nebraska Production, *Dr. Karla Jenkins (20 mins)*

10:35 AM: Summer Cocktail Forage Research in the Panhandle of Nebraska, *Dr. Karla Jenkins (15 mins)*

10:50 AM: Proso millet breeding, genetics and genomics, *Dr. Dipak Santra (20 mins)*

11:10 AM: Grain legumes for western Nebraska: Pea and fenugreek, *Dr. Dipak Santra (20 mins)*

11:30 AM: Sunflower hybrids for western Nebraska: *Dr. Dipak Santra (15 mins)*

11:45 PM: Field research of biotech crops, *Bill Struckmeyer (15 mins)*

Noon – 1:00 PM: Lunch

01:00 PM: Breeding small grains for western Nebraska, *Dr. Dipak Santra (10 mins)*

01:10 PM: Wheat stem sawfly update from 2014, *Dr. Jeff Bradshaw (10 mins)*

01:20 PM: Understanding the Wheat-mite-virus Complex in Wheat, *Dr. Jeff Bradshaw (10 mins)*

01:30 PM: Colorado Proso Millet Association, *Lane Stum*, proso millet producer in south-east Colorado

02:00 PM: Open Session

- What is being done right?
- What is NOT being done right?
- What should be done differently?
- 2015 HPAL Field day in June
- Advisory Board Business Meeting

03:00 PM: Adjourn

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ANNUAL REPORT

2015

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, Rob Higgins

HPAL ADVISORY BOARD
2015-2016

Walt Akeson	815 Duchess Dr., Longmont, CO 80501	308-776-6510	wakeson@earthlink.net
Aaron Berger	Kimball Co. Ext. Office 209 3rd St. Kimball, NE 69145	308-235-3122	aberger2@unl.edu
Deb Brauer	Crossroads CO-OP 800 Greenwood Rd. P.O. Box 153 Sidney, NE 69162	308-254-4230	deb@crossroadscoop.com
Kent Brauer	520 Charles Dr. Sidney, NE 69162	308-254-5755	kurtis_brauer@hotmail.com
Jon Carter	15591 Road 14 Chappell, NE 69129	308-874-2892	jcarter@vistabeam.com
Don Cruise	2809 Road 111 Sidney, NE 69162	308-254-7377	donrcruise@yahoo.com
Chris Cullan	Cullan Farms 6733 Franklin Road Hemingford, NE 69348	308-487-3905	candjcullan@bbc.net
Karen DeBoer	Cheyenne Co. Ext. Office 920 Jackson St. P.O. Box 356 Sidney, NE 69162	308-254-4455	kdeboer1@unl.edu
Ken Disney	Disney Farms 14309 Road 10 Lodgepole, NE 69149	308-483-5673	kennethdisney@yahoo.com
Scott Easterly	10344 Road 12 Sidney, NE 69162	308-254-4052	easterly@peetzplace.com

Carmen Egging-Draper	Farm Credit Services 9562 Rd. 50 Dalton, NE 69131	308-249-4795	carmen.draper@fcsamerica
David Hagstrom	3595 Road 24 South Kimball, NE 69145	308-235-2701	dphagstrom@gmail.com
Bryce Halstead	708 Webster St. Kimball, NE 69145	308-235-2106	lhalstead3@charter.net
Mark Halstead	6333 Road 18 Dix, NE 69133	308-235-7139	markalanhalstead@huskers.unl.edu
Scott Hawthorne	3705 Road 24 South Kimball, NE 69145	308-430-0515	hawthornescott@hotmail.com
Chris Johnson	3605 Road 99 Sidney, NE 6916	308-249-2600	topher450@hotmail.com
Leon Kriesel	Kriesel Certified Seed 4626 Road 111 Gurley, NE 69142	308-884-2424	kcsent@vistabeam.com
Mike Leininger	American National Bank P.O. Box 19 Sidney, NE 69162	308-254-5536	mleininger@anbsidney.com
Alton Lerwick	70585 Carter Canyon Rd. Lyman, NE 69352	308-247-3139	lerwicka@gmail.com
Grant Lerwick	3831 Rd. 17 Harrisburg, NE 69345		glerwick@hotmail.com
Randy Mathewson	2675 Rd. 87 Potter, NE 69156	308-254-6156	rgm@prairieweb.com
Kristin Miller	NRCS 2244 Jackson Street Sidney, NE 69162	308-254-4507	kristin.miller@ne.usda.gov

Pete Miller	14532 Rd. 40 Lodgepole, NE 69149	308-483-5685	pmiller1320@yahoo.com
Clint Norman	Security First Bank P.O. Box 137 Sidney, NE 69162	08-254-4525	cnorman@security1stbank.com
Eugene Radke	3026 Road 199 Big Springs, NE 69122	308-889-3429	garadke1@gmail.com
Jerry Radke	19910 Road 22 Big Springs, NE 69122	308-889-5160	jerryradke5160@gmail.com
Bryan Reimers	10439 Road 58 Dalton, NE 69131	308-377-2403	breimers@panhandlecoop.com
Keith Rexroth	2478 Parkview Rd. Sidney, NE 69162	308-249-1750	rexrothk@msn.com
Doug Schmale	3664 Road 139 Lodgepole, NE 69149	308-483-5505	drylandfarm@yahoo.com
Brian Townsend	180497 Co. Rd. C Mitchell, NE 69357	308-632-3351	townbldg@actcom.net
Jared Truetken	Points West Community Bank 809 Illinois St. Sidney, NE 69162	308-254-7110	jtruetken@pwcbank.com
Merle Vigil	USDA-ARS 40335 Co. Rd GG P.O. Box 40 Akron, CO 80720	907-345-2259	merle.vigil@ars.usda.gov
Tony Walker	1410 Rd 103 Sidney, NE 69162	308-254-5810	tonycrwalker@hotmail.com

PERSONNEL AT HPAL

2015

Employee	Title	Period Worked
Tom Nightingale	Manager	Jan 75 - March 15
Rob Higgins	Manager	April 15 – Dec 15
Paul McMillen	Farm Foreman	Mar 83 - Dec 15
Rob Higgins	Crops Technician	May 91 - April 15
Vernon Florke	Crops Technician	May 07 - Dec 15
Bill Struckmeyer	BQMS Technician	Jan 14 - Dec 15
Travis Orrell	Crops Technician	July 15 - Dec 15
David Wills	Summer Work	Apr 15 - Dec 15
Kali Robb	Summer Work	May 15 - Aug15
David Blanke	Summer Work	May 15 - Aug 15
Duane Nightingale	Summer Work	Apr 15 - Sept 15
Larry Nelson	Summer Work	Apr 15 - Sept 15
Wesley Morgan	Summer Work	May 15 - Aug 15
Emily Gill	Summer Work	May 15 - Aug 15
Hannah Greenwell	Graduate Student	May 15 – Aug 15

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. Jack Whittier	Director, Panhandle Res & Ext Center
Dr. Gary Hergert	Prof of Agronomy/Horticulture
Dr. Jeff Bradshaw	Assoc. Prof of Entomology
Dr. Dipak Santra	Assoc. Prof of Agronomy/Horticulture
Dr. Alexander Pavlista	Prof of Agronomy/Horticulture
Dr. Karla Jenkins	Asst. Prof of Animal Science
Dr. Cody Creech	Asst. Prof of Agronomy/Horticulture
Dr. Mitch Stephenson	Asst. Prof of Range and Forage Specialist
Karen Deboer	Extension Educator
Aaron Berger	Extension Educator
Karen Schultz	Business Manager, PREC
Harrison Boateng	System Support Specialist

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

NAME	ORGANIZATION
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. Teshome Regassa	Research Asst. Professor
Dr. Edward Cahoon	Prof of Biochemistry

RESEARCH TRIALS CONDUCTED DURING 2015

WHEAT and BARLEY

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 Creech	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 Creech	Evaluation of seed treatment combined with fungicide treatments
Clearfield winter wheat	Hergert Higgins Creech	Evaluation of weed control and tolerance of 2-gene CL winter wheat for feral rye control
Planting date & variety selection For management of the wheat Curl mite complex	Hein McMechan Higgins Creech	Evaluation of early and late planting of commercial varieties of winter wheat
Winter wheat	Creech Higgins Orrell	Timing of Gibberellic acid treatments in winter wheat
Winter Wheat	Bhatta Regassa Baenziger Santra Florke	Seeding Rate, Genotype, and Top-Dressed Nitrogen Effects on the Yield and Agronomic Characteristics of Winter Wheat

Winter Barley	Baenziger Santra Florke	Variety trial

FORAGES

TRIAL	STAFF	DESCRIPTION
Winter triticale	Santra Baenziger Florke	Winter triticale varieties
Evaluating summer annual mixtures for beef cattle in dryland crop rotations	Jenkins Creech Higgins	Comparison of annual forage production for beef cattle
Summer Annual inter seeding of perennial pasture multistate trial	Stephenson Jenkins Creech	Inter seeding of cool season pasture with legumes

OILSEED CROPS: SUNFLOWER and WINTER CANOLA

TRIAL	STAFF	DESCRIPTION
Sunflower varieties, oils	Santra Florke Hazen	Dryland and irrigated sunflower varieties
Sunflower varieties, confections	Santra Florke Hazen	Irrigated confection varieties
Winter Canola	Santra Hergert Higgins Creech	Evaluation of no-till, minimum till, and stale seedbeds for winter canola production
Winter Canola	Santra Florke	Winter screening nursery & variety trial

LEGUMES

TRIAL	STAFF	DESCRIPTION
Pea variety trial	Santra Florke Hazen	Dryland variety trial
Pea herbicide trial	Hergert Higgins Creech	Evaluation of pre-emerge and post treatments in field peas
Fenugreek variety trial	Santra Florke Hazen	Irrigated variety trial

MILLET, SORGHUM, CORN

TRIAL	STAFF	DESCRIPTION
Proso millet variety trial	Santra Florke	Dryland & irrigated varieties
Proso millet breeding	Santra Florke Hazen	Bulk selection of proso head rows
Milo Variety Trial	Creech Orrell	Dryland milo varieties
Dryland No-till Corn	Creech Higgins Orrell	Microbiology inoculation study

CATTLE

TRIAL	STAFF	DESCRIPTION
Pasture Trial	Jenkins Greenwell	Evaluating the impacts of field peas on meat tenderness when fed as a pasture supplement or in the finishing diet

2015 HPAL

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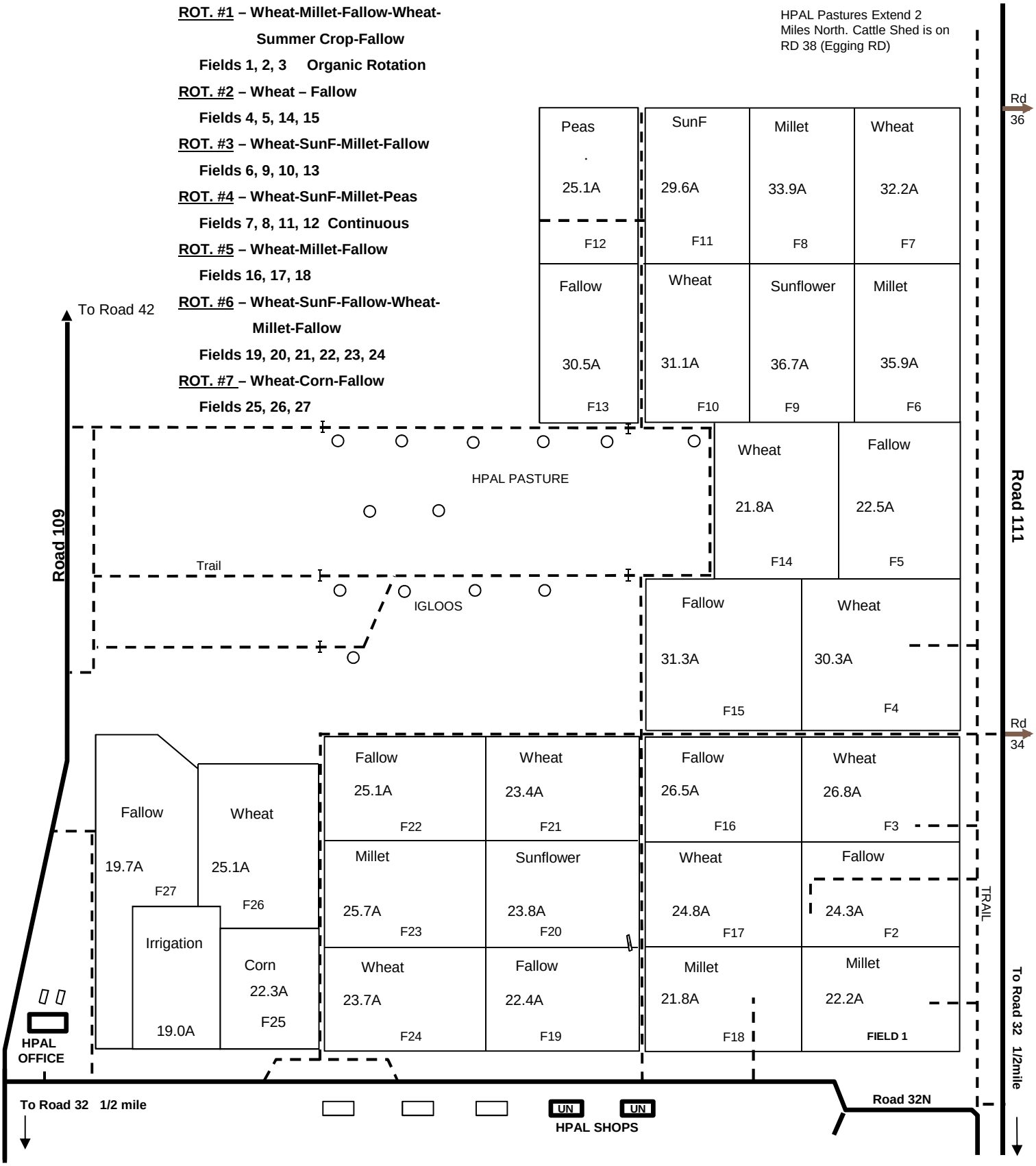
HIGH PLAINS AG LAB

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-Peas
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

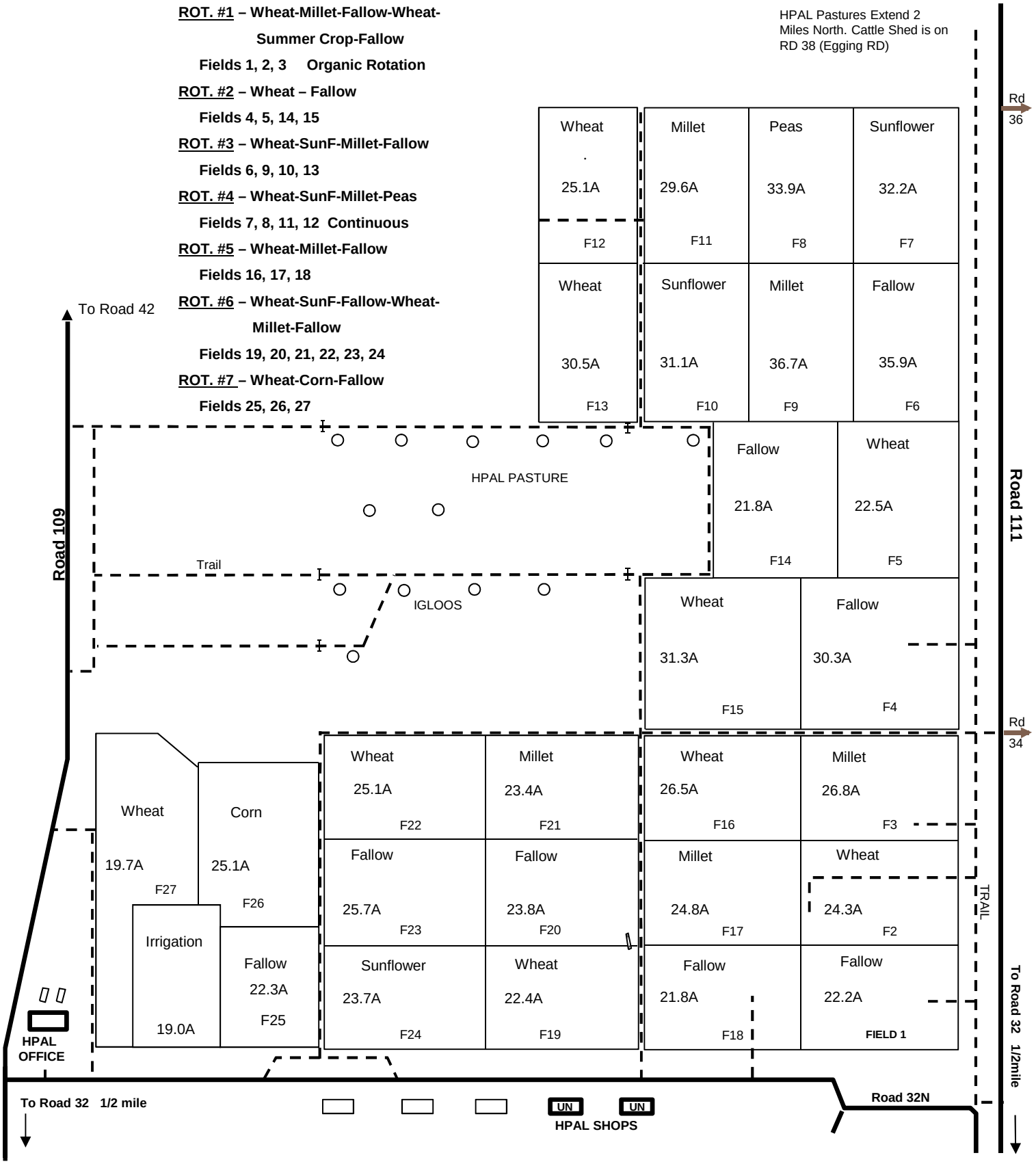


2016 HPAL

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-Peas
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



1 Mile East On RD 32 to Hiway 385 →

YIELD SUMMARIES
2012, 2013, 2014, 2015

ROTATION	2012	2013	2014	2015
R#1	**WHEAT – MILLET – FALLOW – WHEAT – SUNFLOWER – FALLOW; ORGANIC**			
F1	SunF-473 lb/a	Fallow	Wheat-34.6 bu/a	Millet-36.4 bu/a
F2	Fallow	Wheat-40.6 bu/a	Millet-29.0 bu/a	Fallow
F3	Wheat-50.6 bu/a	Millet-0 bu/a-hail	Fallow	Wheat-51.3 bu/a
R#2	**WHEAT – FALLOW**			
F4	Fallow	Wheat-44.3 bu/a	Fallow	Wheat-32.2 bu/a
F5	Wheat-50.8 bu/a	Fallow	Wheat-48.8 bu/a	Fallow
F14	Fallow	Wheat-47.4 bu/a	Fallow	Wheat-38.5 bu/a
F15	Wheat-45.1 bu/a	Fallow	Wheat-44.2 bu/a	Fallow
R#3	**WHEAT – SUNFLOWER – MILLET – FALLOW**			
F6	Fallow	Wheat-39.2 bu/a	SunF-1558 lb/a	Millet-44 bu/a
F9	Millet-2.6bu/a	Fallow	Wheat-31.5 bu/a	Sunflower-1005lb/a
F10	SunF-843lb/a	Millet-10.7 bu/a	Fallow	Wheat-50 bu/a
F13	Wheat-46.3bu/a	SunF-710 lb/a	Millet-36.5 bu/a	Fallow
R#4	**WHEAT – SUNFLOWER – MILLET – FORAGE/PEAS**			
F7	SunF-843lb/a	Millet-0 bu/a-hail	Peas-23 bu/a	Wheat-48.6 bu/a
F8	Forage-Grazed	Wheat-37.5 bu/a	SunF-1773 lb/a	Millet-48 bu/ac
F11	Millet-2.6bu/a	Fallow	Wheat-22.4 bu/a	Sunflower-915 lb/a
F12	Wheat-41.7bu/a	SunF-710 lb/a	Millet-35.8 bu/a	Peas – 37 bu/a

YIELD SUMMARIES (con't)

ROTATION	2012	2013	2014	2015
R#5	**WHEAT – MILLET – FALLOW**			
F16	Wheat-44.6bu/a	Wheat-23.8 bu/a	Millet-41.2 bu/a	Fallow
F17	Wheat-50.3bu/a	Millet-10.7 bu/a	Fallow	Wheat-54.2 bu/a
F18	Millet-42.1bu/a	Fallow	Wheat-49.1 bu/a	Millet-37 bu/ac
R#6	**WHEAT – SUNFLOWER – FALLOW – WHEAT – MILLET – FALLOW**			
F19	Fallow	Wheat-41.9 bu/a	SunF-1534 lb/a	Fallow
F20	Millet-42.9bu/a	Fallow	Wheat-51.2 bu/a	Sunflower-773 lb/a
F21	Wheat-43.6bu/a	Millet-10.7 bu/a	Fallow	Wheat-39.7 bu/a
F22	Fallow	Wheat-30.3 bu/a	Millet-35.5 bu/a	Fallow
F23	SunF-843lb/a	Fallow	Wheat-53.9 bu/a	Millet-41 bu/a
F24	Wheat-43.8bu/a	SunF-969 lb/a	Fallow	Wheat-46 bu/a
R#7	**WHEAT – CORN – FALLOW**			
F25	Corn-41.3bu/a	Fallow	Wheat-53.8 bu/a	Corn-69-bu/a
F26	Wheat-53.5bu/a	Corn-79.3 bu/a	Fallow	Wheat-45.9 bu/a
F27	Fallow	Wheat-41.2 bu/a	Corn-79.5 bu/a	Fallow

CROP	2012	2013	2014	2015
Wheat	47.0 bu/a	34.7 bu/a	43.3 bu/a	45.1 bu/a
Millet	22.6 bu/a	5.8 bu/a-hail	35.6 bu/a	41.3 bu/a
Sunflower	843 lb/a	783.3 lb/a	1621.7 lb/a	898 lb/a
Corn	41.3 bu/a	79.3 bu/a	79.5 bu/a	69bu/a

HIGH PLAINS AG LAB WEATHER DATA
OCTOBER 1, 2014 - SEPTEMBER 30, 2015

	Precipitation		Maximum Temp		Minimum Temp	
Month	Year	Normal	Year	Normal	Year	Normal
October 2014	0.84	0.91	69.0	64.3	38.7	33.8
November 2014	0.45	0.46	48.2	49.8	22.2	21.9
December 2014	0.86	0.32	42.0	40.9	18.7	14.7
January 2015	0.38	0.29	41.8	39.6	19.0	12.5
February 2015	0.79	0.36	42.7	43.3	21.9	16.2
March 2015	0.28	0.89	62.8	50.3	29.3	22.6
April 2015	4.05	1.64	63.6	59.9	34.5	31.3
May 2015	8.98	2.99	63.6	69.4	41.8	41.6
June 2015	2.91	3.15	81.9	79.8	56.3	51.3
July 2015	2.64	2.58	86.4	87.9	57.4	57.4
August 2015	0.36	1.94	87.4	85.9	55.7	55.5
September 2015	0.12	1.40	84.3	77.0	50.8	45.5
TOTAL	22.66	16.93				
YEARLY AVERAGE			64.5	62.3	37.2	33.7

Normal = 68 year average

2015 CROP ROTATION #1
3 Year Stacked – Organic
Fields 1, 2, 3
Wheat, Millet, Fallow, Wheat, Sunflower, Fallow

Operations

Field 1 – 22.2 acres – Proso – Previous crop, Wheat

April 1	Disc
April 22	Disc
May 2	Chisel
June 19	Mulch Finisher
June 22	Planted 15 lb/a Sunrise proso millet
Sept 16	Harvest Proso Millet – stripper header 36 bu/a

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

April 1	Disc
April 22	Disc
May 3	Chisel
June 19	Mulch Finisher
July 28	Chisel w/deadrod
August 15	Mulch Finisher
Sept 1	Mulch Finisher
Sept 12	Planted 55 lb.s/A (Panhandle) winter wheat

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

May 30	Aerial applied Headline 7 oz/acre
July 18	Harvest wheat – yield 50 bu/ac

2015 CROP ROTATION #2
2 Year
Fields 4, 5, 14, 15
Wheat, Fallow

Operations

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

April 27	4 oz/a Beyond
May 30	Aerial applied Headline 7 oz/acre
July 28	Harvest wheat – Yield, 32.2 bu/a
August 8	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz Clarifier (generic dicamba)

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

April 19	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 27	20 oz/a Roundup PowerMax + 8 oz/a LV
August 8	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz Clarifier (generic dicamba)
Sept 21	Planted Settler Cl 55 lb.s/a No-till

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

April 27	4 oz/a Beyond
May 30	Aerial applied Headline 7 oz/acre
July 28	Harvest wheat – Yield, 38.5 bu/a
August 8	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz Clarifier (generic dicamba)

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

April 19	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 27	20 oz/a Roundup PowerMax + 8 oz/a LV
August 8	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz Clarifier (generic dicamba)
Sept 23	Planted Settler Cl 55 lb.s/a No-till

2015 CROP ROTATION #3
4 Year
Fields 6, 9, 10, 13
Wheat, Sunflower, Millet, Fallow

Operations

Field 6 – 35.9 acres – Millet – Previous crop, Sunflower

April 18	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 18	Planted 15 lb/a Sunrise proso millet
June 23	28 oz/a Roundup PowerMax + 2 oz/a Sharpen Pre
Sept 17	Harvest – Stripper Header Yield, 44 bu/a

Field 9 – 36.7 acres – Sunflower – Previous crop, wheat

April 18	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 11	Seed 16,000/a 306 Croplan oil sunflowers
June 13	2.5 pt/a Prowl H2O + 2.8 oz/a Spartan Charge + 16oz/a Roundup
June 28	Replanted 16,000 ppa Croplan 306 Sunflower due to stand
June 29	20 oz/a Roundup - Pre to control emerging grass's
Nov 10	Harvest – Yield 1005 lb/a

Field 10 – 31.1 acres – Wheat – Previous crop, Fallow

April 20	8 oz/a 2,4-d LV6
May 30	Aerial applied Headline 7 oz/acre
July	Harvest 50 bu/ac
August 8	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz/a Clarifier (generic dicamba)

Field 13 – 30.5 acres – Fallow – Previous crop, Millet

April 19	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 28	20 oz/a Roundup PowerMax + 8 oz/a LV
August 1	v-blade
August 19	Mulch finisher
Sept 31	Mulch finisher
Sept 14	Planted 55 lb.s/a Panhandle (dry conditions)

2015 CROP ROTATION #4
4 Year Continuous
Fields 7, 8, 11, 12
Wheat, Sunflower, Millet, Peas

Operations

Field 7 – 32.2 acres – Wheat – Previous crop, Peas

April 16	40 lb.s N
April 24	8 oz/a 2,4-d LV6
May 30	Aerial applied Headline 7 oz/acre
July	Harvest 48.6 bu/ac
August 9	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz/a Clarifier (generic dicamba

Field 8 – 33.9 acres – Proso – Previous crop, Sunflower

April 18	50 lb/a nitrogen
April 31	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 17	Planted 15 lb/a Sunrise proso millet
June 23	28 oz/a Roundup PowerMax + 2 oz/a Sharpen Pre
Sept 17	Harvest – Stripper Header Yield, 48 bu/a

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

April 15	50 lb/a nitrogen
April 29	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 10	Seed 16,000/a 306 Croplan oil sunflowers
June 13	2.5 pt/a Prowl H2O + 2.8 oz/a Spartan Charge + 16oz/a Roundup
June 28	Replanted 16,000 ppa Croplan 306 Sunflower due to stand
June 29	20 oz/a Roundup - Pre to control emerging grass's
Nov 10	Harvest – Yield 915 lb/a

Field 12 – 25.1 acres – Peas – Previous crop, Millet

April 11	Seed 180 lb/a Nette yellow field peas
April 12	1.5 oz/a Optill + 28 oz/a Roundup Powermax
July 29	Harvest peas – Yield, 37 bu/a
Aug 4	25 oz/a Roundup PowerMax + 2 oz/a Sharpen + 8 oz/a LV6
Sept 2	28 oz/a Roundup RT3 + 1.25 oz/a Sharpen
Sept 29	Seed 55 lb/a Panhandle wheat No-till

2015 CROP ROTATION #5
3 Year
Fields 16, 17, 18
Wheat, Millet, Fallow

Operations

Field 16 – 26.5 acres – Fallow – Previous crop, Millet

April 18	50 lb/a nitrogen
April 31	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 25	20 oz/a Roundup PowerMax + 8 oz/a LV
August 9	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz Clarifier (generic dicamba)
Sept 25	Planted Settler Cl 55 lb.s/a No-till

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

April 20	8 oz/a 2,4-d LV6
May 30	Aerial applied Headline 7 oz/acre
July 18	Harvest 54.2 bu/ac
August 8	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz/a Clarifier (generic dicamba)

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

April 19	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 22	Planted 15 lb/a Sunrise proso millet
June 23	28 oz/a Roundup PowerMax + 2 oz/a Sharpen Pre
Sept 17	Harvest – Stripper Header Yield, 37 bu/a

2015 CROP ROTATION #6
6 Year
Fields 19, 20, 21, 22, 23, 24
Wheat, Sunflower, Fallow, Wheat, Millet, Fallow

Operations

Field 19 – 22.4 acres – Fallow – Previous crop, Sunflower

April 19	50 lb/a nitrogen
April 31	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 30	20 oz/a Roundup PowerMax + 8 oz/a LV6
August 1	v-blade
August 18	Mulch finisher
Sept 5	Chisel w/dead rod
Sept 15	Planted 55 lb.s/a Panhandle (dry conditions) Noble drills

Field 20 – 23.8 acres – Sunflower – Previous crop, Wheat

April 15	50 lb/a nitrogen
April 29	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 10	Seed 16,000/a 306 Croplan oil sunflowers
June 13	2.5 pt/a Prowl H2O + 2.8 oz/a Spartan Charge + 16oz/a Roundup
Nov 10	Harvest – Yield 773 lb/a

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

April 20	8 oz/a 2,4-d LV6
May 30	Aerial applied Headline 7 oz/acre
July 18	Harvest 39.7 bu/ac
August 6	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz/a Clarifier (generic dicamba)

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

April 15	50 lb/a nitrogen
May 1	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 30	20 oz/a Roundup PowerMax + 8 oz/a LV
August 7	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz Clarifier (generic dicamba)
Sept 26	Planted Panhandle 55 lb.s/a No-till

Field 23 – 25.7 acres – Millet – Previous crop, Wheat

April 19	50 lb/a nitrogen
April 30	28 oz/a Roundup PowerMax + 8 oz/a LV6
June 23	Planted 15 lb/a Sunrise proso millet
June 23	28 oz/a Roundup PowerMax + 2 oz/a Sharpen Pre
Sept 17	Harvest – Stripper Header Yield, bu/a

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

April 22	8 oz/a 2,4-d LV6
May 30	Aerial applied Headline 7 oz/acre
July 19	Harvest 46 bu/ac
August 9	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz/a Clarifier (generic dicamba

2015 CROP ROTATION #7
3 Year
Fields 25, 26, 27
Wheat, Corn, Fallow

Operations

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

May 5	80lb.s Nitrogen
May 8	Attempted to plant corn
June 2	Planted Dekalb 46-20RIB 16,000 ppa
June 3	32 oz/a Roundup, 1.1lb Atrazine 90df Pre
July 14	24 oz/a Roundup Post Application for small grass's
Nov 3	Harvested Corn 69 bu/a

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

April 24	8 oz/a 2,4-d LV6
May 30	Aerial applied Headline 7 oz/acre
July 20	Harvest 46 bu/ac
August 10	28 oz/a Roundup RT3 + 2 oz/a Sharpen + 9 oz/a LV6 + 4 oz/a Clarifier (generic dicamba

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

April 19	50 lb/a nitrogen
May 1	28 oz/a Roundup PowerMax + 8 oz/a LV6
July 1	20 oz/a Roundup PowerMax + 8 oz/a LV6
August 3	v-blade
August 14	Mulch finisher
Sept 2	Mulchfinisher
Sept 11	Planted 55 lb.s/a Panhandle (dry conditions) Noble drill Did not emerge until 1st week October.

Grain Sorghum Variety Trial at High Plains Ag. Lab

Cody Creech, Dryland Cropping Systems Specialist, Robert Higgins, Research Supervisor, and Travis Orrell, Research Technician II,
Dryland Cropping Systems, Panhandle Research and Extension Center,
University of Nebraska-Lincoln, Scottsbluff, NE

Objective

In Nebraska, grain sorghum production in 2015 is estimated at 23.0 million bushels, up 76% from 2014. Total area harvested for grain, at 240,000 acres, is up 50% from 2014. Because of the current commodity markets, producers are looking for alternative crops, like grain sorghum, that produce well with limited water and are marketable. Overall, the goal of the trial was to identify early maturing grain sorghum cultivars which have reliably high yield potential in the high plains ecoregion of western Nebraska.

Approach

Eleven cultivars of grain sorghum were planted on June 2nd and grown under dryland conditions in a randomized complete experimental design with four replicates. Plots were four rows wide and 40 feet long. Nitrogen was applied on July 1st at 40lbs/A, and the plots were harvested on November 5^{th,} 2015 with a Massey-Ferguson MF-8 plot combine.

Results

Table 1. Nebraska Grain Sorghum Variety Test-2015 (HPAL, Dryland)

Hybrid	Company	Maturity	Bu/A
KS310	Chromatin	Early	76.7
DKS29-28	DEKALB	Early	72.6
DKS28-05	DEKALB	Early	72.5
DK28E	DEKALB	Early	71.2
AS216	Arrow Seed	Early	70.1
SPX12914	Chromatin	Experimental	64.2
1G588	MYCOGEN	Early	61.1
1G537	MYCOGEN	Early	60.3
SPX11814	Chromatin	Experimental	60.3
AS125	Arrow Seed	Med - Early	60.1
NK5418	Chromatin	Medium	55.3
Mean			**65.9**

Discussion

This was an excellent year for grain sorghum at the High Plains Ag. Lab because of the higher than average precipitation through the spring as well as the extended fall we experienced. Sorghum yields were admirable for dryland conditions. As can be expected in dryland conditions on the high plains, early maturing cultivars performed better than medium maturing cultivars.

Further Research

It is planned to continue and expand this variety trial in June 2016 as well as implement seeding rate and row spacing trials.

2015 Herbicide Evaluations at HPAL in Field Peas and Two-gene Clearfield Winter Wheat

Robert K. Higgins, Dr. Gary Hergert, Dr. Cody Creech, Travis Orrell

Early Preplant Herbicides for Grass and Broadleaf Control in Peas in Sidney, NE 2015

The objective of this study was to evaluate crop injury and efficacy of several herbicides labeled for use in dry pea production. A field study was initiated at the High Plains Agricultural Laboratory (HPAL) near Sidney, NE during 2015

Material and Methods

The experimental design was a randomized complete block with three replications. Plots were 10 feet wide by 30 feet long. Herbicide treatments were applied with an ATV-mounted sprayer set to deliver 15 gallons/acre at three miles/hour and 25 psi. On April 6, 2014 early pre-plant (EPP) treatments were applied. April 8, 2014, yellow dry pea (cv. Nette) was planted at a rate of 180 lb.s /A into proso millet residue with a John Deere 1560 no-till drill. On April 9, 2014 one preemergence (Pre) treatment was applied.

Results and Discussion

Due to weather constraints in March we were not able to apply our (EPP) treatments as early as intended. The weeds at the time of application treatments were downy brome and marestail. Peas were direct harvested with a Mf-8 plot combine on July 30th, 2015. All treatments in this study are labeled for dry pea production in Nebraska. All treatments performed well in respect to the weeds present for weed control and no crop injury was observed (Table 1). Visually the combination of Prowl H20 at 2 pt/a and Sharpen at 2 oz/a provided adequate control late into the growing season (Table 1).

Table 1. Early Preplant Herbicides for Grass and Broadleaf Control in Peas in Sidney, NE 2015.

Treatment	Rate & Timing	Crop Injury	% Downy Brome Control	% Marestail Control	Yield (Bu/ac)
Roundup	32 fl oz/a EPP	0	100	100	43
Sharpen	1.5 fl oz/a EPP				
Prowl H2O	1.5 pt/a Epp				
Roundup	32 fl oz/a Epp	0	100	100	41
SHARPEN	2 fl oz/a Epp				
Prowl H2O	2 pt/a Epp				
Roundup	32 fl oz/a Pre	0	100	100	45
Sharpen	1.5 fl oz/a Pre				
Untreated		0	0	0	35
LSD (5%)		0	0	0	16

Evaluation of Fall and Spring Applied Pea Herbicides at Sidney, NE 2015

The objective of this study was to evaluate fall and spring applications of herbicide combinations in dry pea production

Materials and Methods

The experimental design was a randomized complete block with three replications. Plots were 10 feet wide by 30 feet long. Herbicide treatments were applied with an ATV-mounted sprayer set to deliver 15 gallons/acre at three miles/hour and 25 psi. Fall treatments were applied on November 22, 2014 into proso millet residue. The only weeds visible during the fall treatments was downy brome in the 1-2 leaf stage. No broadleaf weeds were visible at the time of the fall applications. On April 6, 2014 early pre-plant (EPP) treatments were applied. On April 8, 2014 yellow dry pea (cv Nette) was planted at a rate of 180 lb.s /A into proso millet residue with a John Deere 1560 no-till drill. The weeds at the time (EPP) were downy brome and marestail. Pea harvest was conducted on July 30th, 2015

Results and Discussion

Due to weather constraints in March, we were not able to apply our (EPP) treatments as early as intended. Having the option to apply a fall application in field pea could allow producers another option in attempting to control late fall emerging weeds and possibly allow for sufficient weed control going into the early spring months. No visual crop injury was observed (Table 2). The combination of fall and (Pre) combinations provided excellent control of marestail (Table 2). Yield was definitely decreased in the untreated check (Table 2). The increasing resistance or tolerance of marestail, kochia and Russian-thistle to some chemical compounds will lead to more research on herbicides and timing in field peas for future research.

(See Table 2 on next page)

Table 2. Evaluation of Fall and Spring Applied Pea Herbicides at Sidney, NE 2015

Treatment	Rate	Timing	Crop Injury	Downy Brome	Marestail	Yield (Bu/ac)
			% Crop Injury and Weed Control (5/21/15)			7/30/15
Authority MTZ	14 oz/a	Fall	0	100	98	33
Roundup	22 fl oz/a	Pre				
Authority MTZ	10 oz/a	Fall	0	100	100	34
Roundup	22 fl oz/a	Pre				
Valor SX	2.5 oz/a	Fall	0	100	100	35
Roundup	22 fl oz/a	Pre				
Valor SX	2.5 oz/a	Fall	0	100	100	28
Spartan Charge	4.5 fl oz/a	Pre				
Roundup	22 fl oz/a	Pre				
Authority MTZ	10 oz/a	Fall	0	100	100	30
Aatrex-DF	16 oz/a	Fall				
Roundup	22 fl oz/a	Pre				
Authority MTZ	8 oz/a	Fall	0	99	100	32
Authority MTZ	6 oz/a	Pre				
Roundup	22 fl oz/a	Pre				
Authority MTZ	10 oz/a	Fall	0	54	100	31
Authority MTZ	4 oz/a	Pre				
Roundup	22 fl oz/a	Pre				
Spartan Charge	4.5 fl oz/a	Fall	0	99	100	29
Broadaxe	22 fl oz/a	Pre				
Roundup	22 fl oz/a	Pre				
Spartan Charge	4.5 fl oz/a	Fall	0	49	93	28
Spartan Charge	3.75 fl oz/a	Pre				
Roundup	22 fl oz/a	Pre				
Authority MTZ	10 oz/a	Fall	0	83	100	32
Spartan Charge	4.5 fl oz/a	Pre				
Roundup	22 fl oz/a	Pre				
Spartan Charge	6 fl oz/a	Pre	0	100	100	29
Roundup	22 fl oz/a	Pre				
Broadaxe	26 fl oz/a	Pre	0	100	99	30
Roundup	22 fl oz/a	Pre				
Optill	2 oz/a	Pre	0	91	99	36
Roundup	22 fl oz/a	Pre				
Untreated			0	0	0	20
LSD (5%)				25.1	14.5	1.5

Two-gene Clearfield winter wheat tolerance to Beyond in combination with broadleaf herbicides

The objective of this study was to evaluate the efficacy of Beyond and various broadleaf herbicides applied in the spring to two-gene Clearfield wheat for feral rye control and crop response.

Materials and Methods

The experimental design was a randomized complete block with four replications. Feral rye seeds were broadcast by hand and then incorporated with a mulch treader immediately prior to wheat seeding. The Clearfield wheat cultivar 'Brawl CL Plus' was seeded on September 20, 2014 at a seeding rate of 60 pounds/acre. Plots were 10 feet wide by 25 feet long. Herbicide treatments were applied with an ATV-mounted sprayer set to deliver 14 gallons/acre at 3 miles/hour and 20 psi. Spring treatments were made to feral rye on April 24, 2015 when rye plants had numerous tillers. Feral rye pressure moderate to heavy. The majority of the feral rye was starting to become erect and was 6-10" in height and was jointed above the ground 3 – 5". Winter wheat at the time of the spring application had 4 to 5 tillers and an extended leaf height of 4 to 8 inches and was jointed just above the ground surface. UAN was applied at 20% v/v along with MSO concentrate with Leci-Tech at 1% v/v to all treatments. The study was located on an Alliance silt loam soil with 1.6% organic matter content and a pH of 6.5.

Results and Discussion

The growth stage winter wheat in the early spring of 2015 was ahead of average development seen in most years. A majority of winter wheat in the panhandle was jointed in mid-April. Plots were rated for visual crop injury and feral rye control on June 5, 2015. Crop injury was visual in some treatments but was not severe enough to decrease yield (Table 3). Typical crop injury symptoms were leaf chlorosis and slight visual tip burn. Feral rye control was good to excellent for this late of a treatment in the spring (Table 3). Typically what we have seen over the years is feral rye control is best achieved with fall applications. Grain yields were not adjusted for foreign material or dockage. The allowable percent of foreign material for US No. 1 and No. 2 wheat is 0.4 and 0.7%, respectively. Foreign material levels of greater than 5% result in grain being classed as feed grain, which is often not accepted at grain elevators. **More research is needed to develop these tank mixes and labeling. At this moment, these tank mixes are not labeled for this use.**

(See Table 3 on next page)

Disclaimer

Commercial companies are mentioned in this publication solely for the purpose of providing specific information. Mention of a company does not constitute a guarantee or warranty of its products by the Agricultural Research Division, University of Nebraska-Lincoln, or an endorsement over products of other companies not mentioned. This publication also reports research involving pesticides. It does not contain recommendations for their use, nor

does it imply that the uses discussed herein have been registered. All uses of pesticides must be registered by appropriate federal and state agencies before they can be recommended.

Table 3. Two-gene Clearfield winter wheat tolerance to Beyond in combination with broadleaf herbicides

Treatment	Rate	Crop Injury	% Rye Control	% Dockage	% Foreign Matter	Yield (Bu/ac)
Beyond	6 fl oz/a	6.3	85	1.0	0.7	41
Beyond 2,4-D LV Ester	6 fl oz/a 16 fl oz/a	0	91	1.1	0.3	46
Beyond Barrage HF	6 fl oz/a 19 fl oz/a	1.3	89	1.1	0.7	37
Beyond Huskie	6 fl oz/a 15 fl oz/a	0	90	1.0	0.6	46
Beyond Widematch	6 fl oz/a 21.3 fl oz/a	1.3	91	1.0	0.6	34
Beyond Bronate Advanced	6 fl oz/a 16 fl oz/a	1.3	90	1.0	0.3	40
Beyond Starane Ultra	6 fl oz/a 6.4 fl oz/a	0	88	0.9	0.5	42
Beyond Clarity	6 fl oz/a 4 fl oz/a	0	93	0.6	0.3	49
Beyond MCPA-Ester	6 fl oz/a 16 fl oz/a	2.5	89	0.9	0.3	45
Untreated		0	0	1.3	9	37
LSD (5%)		4.3	7.2	0.37	0.17	11

UAN was applied at 20%v/v along with MSO concentrate with Leci-Tech at 1%v/v to all treatments

Evaluating the Feeding Value of Field Peas for Growing and Finishing Cattle in a Western Nebraska Production System

Karla H. Jenkins, Cow/Calf Specialist Panhandle R&E Center
James MacDonald, Assoc. Prof. Beef Systems Specialist, UNL
Matt Luebbe, Feedlot Specialist Panhandle R&E Center
Chris Calkins, Prof. Meat Science, UNL

With almost every farm input increasing in cost, livestock producers are looking for alternative feed sources. These alternative feeds are most effective when they are plentiful, locally sourced, and most importantly, competitively priced. Field peas have gained popularity in recent years among farmers and cattle feeders in the Northern Plains. Historically, in western Nebraska, there has not been an established human food consumption market established for field peas so the entire crop has gone to pet and animal feed. However, State Line Bean Producers Cooperative now accepts field peas for the human consumption market. This development has increased the acres devoted to field pea production and State Line Bean is projecting more acres in the future. Those peas not suitable for human consumption; and not sold for pet food will increase the bushels of field peas available to cattle feeders. Establishing a market or use for the cull peas is critical to the establishment of the field pea acres for human consumption because producers need the security of knowing the crop will have some value to some sector before they will commit to the investment. The fact that field peas are a legume, thus fixing nitrogen in the soil, provides an extra incentive for farmers to plant them for agronomic benefits to the fields. Field peas are also convenient to incorporate into a farming operation, as they utilize common grain planting and harvesting equipment.

Previous research at the University of Nebraska has determined that field peas can replace 20-30% of the diet dry matter usually supplied by corn without negatively impacting finishing cattle performance Field peas have also been shown to increase tenderness when fed to finishing cattle They also make a good binder for distillers grains cubes for supplementing pasture cattle, but other work supplementing field peas to grazing cattle is limited. However, field peas are high in rumen degradable protein which is important for the rumen microbial population of cattle grazing medium to low quality grass and the overall crude protein ranges from 18-26%. The starch content is approximately 30% lower than corn. So, although the energy content is lower, negative associative effects of starch on fiber digestion may be reduced when supplementing field peas rather than corn. Furthermore, supplemental feeds such as distillers grains and corn must be transported long distances to reach western Nebraska and eastern Colorado and Wyoming. Therefore it may be economically advantageous to use locally grown field peas to improve grazing cattle performance rather than more costly imported supplements.

Previous research determined that cattle supplemented dry rolled corn while grazing wheat pasture were more efficient during the feedlot finishing phase than cattle supplemented dried distillers grains or unsupplemented cattle. Field peas also contain starch, but it is unknown whether field peas produce this same effect. Producers have also questioned whether feeding field peas in the grazing phase of the system will impact carcass tenderness in the way that feeding field peas in the finishing phase does. Additionally, very little is known about the impacts of field pea supplementation on the digestibility of forage based diets. Therefore, the objectives of this current field pea research are to 1) evaluate field peas as a supplement for grazing cattle relative to corn, 2) determine if the impact of field

peas on tenderness can be realized by supplementation in the growing phase, and 3) to evaluate the impact of field peas on digestibility of low quality forage as well as better quantify the degradable intake protein content of field peas.

Performance Study

This study is arranged in a 2*3 factorial design. One hundred fourteen crossbred steers (762 lb) were allotted randomly to one of twelve pastures (10 head/pasture in 9 pastures; 8 head/pasture in 3) in Yr. 1 and 114 crossbred heifers (550 lb) in Yr. 2. Pastures were assigned to treatments. The treatments on the grazing segment were the first part of the factorial design with treatments being 1) no supplement, 2) field peas, or 3) dry-rolled corn + urea and solubles to equal the degradable protein of the field peas supplemented at 0.5% of body weight. The cattle grazed the crested wheatgrass pastures at the High Plains Ag Lab near Sidney, NE. The second half of the factorial includes feeding the cattle a dry-rolled corn based finishing diet with or without field peas. Cattle performance and carcass characteristics will be measured. This experiment will be conducted over two years to improve statistical power and account for environmental variation of grazing conditions.

Meat Science Analysis

Loins from all 114 steers in year 1 and heifers in year 2 will be bought back from the packing plant and tested for tenderness using the Warner Bratzler Shear Force method. Additionally, how field peas affect the fatty acid profile in meat is not well identified. Therefore, fatty acid analysis will be conducted as well. Retail display will be conducted to determine if field peas impact discoloration in the meat counter. Oxidation (which impacts color and shelf life) will be measured 0, 4, and 7 days after retail display.

Metabolism Study

A metabolism study is being conducted evaluating the effects of field peas on digestion characteristics in both low and high quality forage diets to determine how supplementing field peas on cool season grasses in the Nebraska Panhandle might impact forage digestion.

Initial Results

The grazing segment of both years and the finishing segment of year 1 are all that are completed at the time of this publication. The heifers from Yr. 2 will be harvested in February. Cattle supplemented with peas or corn plus urea and solubles had greater final body weight and gained more than nonsupplemented cattle during the grazing phase (Table 1). Cattle supplemented with corn+ urea and solubles weighed more and gained more than cattle supplemented with peas. Cattle supplemented with peas had acceptable pasture gains. Peas were fed whole and supplemented in bunks. Cattle fed the corn + urea and solubles were also fed in bunks. It is surprising the cattle on the corn treatment gained better than the cattle on the pea treatment as the negative associative effects of starch were expected to suppress fiber digestion. However, rains and cool temperatures kept the cool season grass vegetative and fiber digestion may have not been the issue it would have been in other years. With protein being kept constant between the two supplements, the additional energy of the corn improved gain.

During the finishing phase (Yr.1) non-supplemented cattle experienced compensatory gain, therefore ADG was greater for those cattle than either supplemented group regardless of finishing diet (Table 2). Non-supplemented cattle were more efficient than supplemented cattle when finished with

peas but performed similarly to cattle supplemented peas when finished without peas. Carcass characteristics were unaffected by growing or finishing treatments.

Table 1. Effect of corn and pea supplementation on performance of growing calves: Yr.1 & 2

					P-		
Treatment[1]	Control	Corn	Peas	SED	Treatment	Year	Trt*Year
Initial BW, lb	656	654	654	3	0.84	0.10	0.91
Ending BW,	835[c]	910[a]	879[b]	9.5	<0.01	0.14	0.62
ADG, lb/d	1.36[c]	1.95[a]	1.72[b]	0.08	<0.01	0.14	0.34

[abc] Within a row, means without a common superscript differ.

[1] Treatments: Cattle grazed 117 days (2014) or 142 days (2015) either without supplement or supplemented at 0.5% y weight with either dry rolled corn or field peas.

Table 2. Effect of field peas on performance in finishing diets: Year 1

Finishing Trt[1]	No Peas			Peas			*P*-value			
Growing Trt[2]	Control	Corn	Peas	Control	Corn	Peas	SED	Growing	Finishing	Interaction
Initial BW, lb	899[cd]	984[a]	926[c]	872[d]	951[b]	949[b]	12.5	<0.001	0.128	0.058
Final BW, lb[3]	1428	1460	1417	1402	1422	1411	32.67	0.458	0.266	0.791
ADG, lb	4.25[a]	3.69[b]	4.03[b]	4.21[a]	3.87[b]	3.57[b]	0.178	0.036	0.342	0.141
DMI, lb	32.2	31.3	30.6	31.7	31.3	31.5	0.906	0.367	0.805	0.553
G:F, lb:lb	0.131[a]	0.120[b]	0.131[a]	0.136[a]	0.123[b]	0.116[b]	0.005	0.027	0.339	0.057
Carcass Performance										
HCW, lb	900	920	893	883	896	889	20.65	0.459	0.268	0.798
12th Rib Fat, in.	0.50	0.51	0.57	0.53	0.50	0.54	0.038	0.151	0.834	0.630
Ribeye Area, in^2	13.9	14.1	13.7	13.2	13.9	13.3	0.551	0.422	0.240	0.832
Marbling[4]	492	482	499	497	497	482	38.2	0.977	0.959	0.843
Calculated YG[5]	3.23	3.29	3.41	3.44	3.16	3.53	0.232	0.415	0.635	0.589

[abcd] Within a row, means without a common superscript differ.

[1] Finishing Treatment: Cattle with peas in the diet had 20% of the dry matter of the diet as peas (by displacing dry rolled corn). The "No Peas" diet still included that 20% as dry rolled corn.

[2] Growing Treatment: Cattle were grazed for 117 days either without supplement or supplemented at 0.5% of body weight with either dry rolled corn or field peas depending on assigned treatment.

[3] Final BW: Calculated as HCW ÷ 0.63

[4] Marbling: 400 = Slight[00] : 500 = Small[00]

[5]Calculated Yield Grade: 2.50 + (2.5 × 12th Rib Fat, in.) – (0.32 × REA, in^2) + (0.2 × 2.5) + (0.0038 × HCW, lb)

Summer Cocktail Forage Research in the Panhandle of Nebraska

Karla H. Jenkins, Cow/calf Range Management Specialist, Cody Creech, Dryland Cropping Specialist, Rob Higgins, Research Manager, Josh Buttle, Research Technician

The Nebraska Panhandle is in a unique environment in that it has low rainfall (12-14" annually) and also a high elevation (3800-just over 5000 ft.). The challenge this creates is that most permanent pastures are cool season predominate and therefore have a summer slump resulting in low quality and quantity. The additional challenge is in planting annual forages to supplement the permanent pastures. The high elevation prolongs soil warm up and the lack of moisture can make emergence a challenge.

Across the Midwest forage cocktail mixtures have been gaining popularity in crop rotations. Typically at least three components are included in these mixtures: an annual grass for biomass production, a legume to add nitrogen to the soil, and a brassica or some deep rooted crop to alleviate soil compaction. While it is important to leave some residue of these crops to prevent erosion and capture moisture, if at least some utilization of the crop could be realized for cattle production, it would reduce grazing pressure on permanent pastures that often need relief from drought.

Six treatments were evaluated as forage options for beef cattle in western Nebraska. The forages planted were 1) a monoculture of brown mid-rib sorghum sudangrass, 2) a monoculture of German foxtail millet, 3) BMR sudangrass, soybeans, and a forage collard, 4) German foxtail millet, soybeans, a forage collard, 5) BMR sudangrass, cowpeas, and a forage collard, or 6) German foxtail millet, cowpeas, and a forage collard. The objective of the study was to compare the mixtures to the monocultures and evaluate any differences in tonnage produced, and the quality (crude protein and total digestible nutrients (TDN), acid detergent fiber (ADF)). Each treatment was replicated three times over a two year period. The forages were planted June 27and harvested September 9 in 2014 and were planted June 26 and harvested September 5, 2015 on dryland acres. The soybeans did not appear to come up in 2014 but the cowpeas did very well. In 2015 both legumes emerged but production was somewhat limited in some plots. The tons of dry matter produced, crude protein (CP), TDN, and ADF of both years combined are shown in Table 1. The BMR sudangrass and the BMR sudangrass, soybeans, and forage collard produced the most tonnage with the German foxtail millet being statistically similar to the BMR sudangrass, soybeans, forage collard mix. Possibly, the reduced yield of the soybeans in the mixture made those treatments similar. The crude protein was lowest in the BMR sudangrass monoculture, most likely a function of the increased tonnage for that treatment. Total digestible nutrients were above 65% for all treatments making all the forage combinations a good quality forage resource for grazing cattle or to be used as a hay crop. Acid detergent fiber was lowest for treatments containing mixtures.

This study did not look at agronomic impacts of planting cocktails, only the quality of the forage mixtures for beef cattle. As previously mentioned, the crops were planted the last week of June. Possibly, more summer growth would have occurred if the crops had been planted the second week of June. Previous research at the High Plains Ag Lab near Sidney, NE has indicated that the window of opportunity for planting summer annuals in the Panhandle is fairly narrow. In the first year of this study, the forage did not experience a lot of growth in July and would have been difficult to graze at that time. Rainfall returned to the area the very end of July and in early August and the forages grew rapidly. For producers trying to manage summer annuals for grazing, this would have been challenging. In the second year, rainfall was not a limiting factor to growth but July was cooler than normal which may have limited growth somewhat. However, if a producer wanted the forages in this experiment for fall windrow grazing or winter hay, it did produce acceptable tonnage and quality by early September. This research was funded by the Nebraska Cattlemen's Foundation and the seed was supplied by Green Cover Seed in Bladen, NE.

	Tons/acre DM	CP, %DM	TDN, % DM	ADF, % DM
BMR Sudangrass	2.3^{a}	7.3^{a}	65.4^{a}	33.2^{a}
Foxtail Millet	1.8^{bcd}	9.7	66.2^{a}	32.7^{a}
Sudan/soybeans/collards*	2.0^{ac}	9.8	67.3^{ab}	31.5^{ab}
Millet/soybeans/collards*	1.5^{d}	11.9	69.4^{b}	29.6^{b}
Sudan/cowpeas/collards	1.5^{d}	10.4	69.1^{b}	29.7^{b}
Millet/cowpeas/collards	1.3	11.7	67.3^{ab}	31.3^{ab}

Means with unlike superscripts differ ($P < 0.05$).
*Soybeans did not contribute any dry matter in year 1.

Proso Millet: Breeding, Genetics and Genomics

Dipak K. Santra, Santosh Rajput, Vernon Florke, and Allison Hazen
Alternative Crops Breeding Program, Panhandle Research & Extension Center,
University of Nebraska – Lincoln, Scottsbluff, NE 69361

Goal and objective

Goal of this project was to develop high yielding proso millet cultivars for western Nebraska and other regions of the central High Plains of the USA following conventional and modern breeding approaches. Objectives in 2015 were (1) testing proso millet breeding population at different nurseries (early generation, preliminary, elite and variety trial), (2) evaluation of germplasm for desired agronomic traits and (3) evaluation of segregating populations for mapping genes and QTLs of various traits of economic importance (e.g. lodging & shattering resistance, maturity, plant, height, panicle characteristics, seed size, and color)

Approach

In 2015, the following proso millet breeding nurseries were evaluated at the High Plains Ag. Lab (HPAL):

<u>F_3 nursery</u>:

In the field, 19 F_3 populations were planted under dryland condition in a 25 feet long 8-rows plot with 7.5 inches between rows (i.e. 5' x 25') at a seeding rate of 15 lbs/acre. Seventeen F_3 populations were visually selected on general agronomic appearance based mainly on plant height, flowering date, straw strength, and visually estimated yield potential. Each selected population was advanced by randomly sampling approximately 75 spikes (syn. heads) in September, though especially meritorious three bulks had a sample of 200 spikes selected. Selected spikes were threshed individually and will be planted in a head row nursery in summer of 2016.

<u>Head-rows (F_4)</u>:

A total of 1000 head rows ($F_{3:4}$) were planted as a single 5 feet row (0.5 to 1g seed/row) in a four row set (e.g. 4 different head rows were planted in the set) with 12 inches between rows using a four-row drill. Approximately 200 head rows were selected visually on the basis of uniformity, agronomic appearance, and on visually selecting for good seed quality after harvest. Seed ($F_{3:5}$) from the selected head rows will be planted as single plot (5' x 25') in preliminary nursery in 2016.

<u>Preliminary yield trial of F_5 and F_6 lines</u>:

One hundred lines ($F_{3:5}$) were planted under dryland in a 25 feet long 8-rows plot with 7.5 inches between rows (i.e. 5' x 25') at a seeding rate of 15 lbs/acre. Selection of plots were based on uniformity and general agronomic appearance (mainly plant height measured from the soil surface to the tip of the spikes, flowering date measured as the number of days after planting Jan.

1 to when 50% of the emerged spikes had extruded anthers, straw strength measured using a scale of 1 to 10 with 1 being little to 10% lodging and 10 being 100 % lodged; grain yield, and grain volume weight). Result of the preliminary trial is shown in Table 1.

Table 1. Proso millet preliminary trial nursery - 2015 (HPAL, Dryland). Trial was planted as unreplicated plot (5'x25') on June 21, 2015 and harvested on October 14, 2015. Yield and test weight (bushel weight) were reported at 12% grain moisture since grain moisture significantly varied among the plots. Names in **bold** are check varieties.

Plot' 15	Name of line	Yield Rank	Yield (lbs/acre)	Bushel Weight (lbs/bu)	Plant Height (inches)	Heading (days after Jan.1)	Pedigree
1063	PMx11.14-10	1	1314	50	31	226	Huntsman (4-2)/ Rise (4-2)
1067	PMx11.14-30	2	1208	49	39	227	Huntsman (4-2)/ Rise (4-2)
1060	PMx11.13-70	3	1175	49	39	223	Huntsman (4-2)/ Minsum
1027	PMx11.4-83	4	1175	49	34	222	Sunrise (2-1)/Huntsman
1047	PMx11.12-22	5	1154	50	34	227	Huntsman (5-1)/Horizon(4-1)
1083	HXR-2-77	6	1148	50	30	227	HuntsmanXRise
1080	HXR-2-53	7	1099	49	30	227	HuntsmanXRise
1037	PMx11.10-66	8	1097	47	37	222	Horizon (5-2)/Plateau
1029	PMx11.4-87	9	1097	49	38	223	Sunrise (2-1)/Huntsman
1079	HXR-2-41	10	1077	50	38	227	HuntsmanXRise
1059	PMx11.13-64	11	1074	48	35	226	Huntsman (4-2)/ Minsum
1049	PMx11.12-38	12	1055	50	34	227	Huntsman (5-1)/Horizon(4-1)
1045	PMx11.12-19	13	1055	49	33	227	Huntsman (5-1)/Horizon(4-1)
1065	PMx11.14-26	14	1034	47	35	224	Huntsman (4-2)/ Rise (4-2)
1051	PMx11.13.2	15	1027	48	38	224	Huntsman (4-2)/ Minsum
1048	PMx11.12-23	16	1024	47	31	227	Huntsman (5-1)/Horizon(4-1)
1028	PMx11.4-85	17	1022	51	34	224	Sunrise (2-1)/Huntsman
1043	PMx11.12-15	18	1020	48	29	225	Huntsman (5-1)/Horizon(4-1)
1013	PMx11.3-28	19	1015	48	28	221	Huntsman(9-2)/174-7-13
1021	PMx11.4-2	20	1013	48	37	221	Sunrise (2-1)/Huntsman
1081	HXR-2-61	21	1012	47	28	229	HuntsmanXRise
1032	PMx11.10-5	22	1010	46	29	221	Horizon (5-2)/Plateau
1082	HXR-2-75	23	1004	49	31	227	HuntsmanXRise
1099	HXM-12-127	24	1001	47	33	222	HuntsmXMinsum
1016	PMx11.3-44	25	1000	47	31	224	Huntsman(9-2)/174-7-13
1030	PMx11.4-91	26	999	48	34	222	Sunrise (2-1)/Huntsman
1036	PMx11.10-61	27	997	49	33	222	Horizon (5-2)/Plateau
1003	**Earlybird**	28	996	46	34	220	**check**
1033	PMx11.10-9	29	994	48	34	222	Horizon (5-2)/Plateau
1035	PMx11.10-51	30	992	49	30	222	Horizon (5-2)/Plateau
1004	**Huntsman**	31	992	49	38	227	**check**
1005	**Sunrise**	32	990	47	36	225	**check**

1089	HXM-10-52	33	984	52	38	227	HuntsmXMinsum
1085	HXR-2-92	34	982	50	32	227	HuntsmanXRise
1061	PMx11.14.2	35	981	49	33	227	Huntsman (4-2)/ Rise (4-2)
1084	HXR-2-89	36	981	50	32	227	HuntsmanXRise
1091	HXM-12-11	37	974	48	37	224	HuntsmXMinsum
1055	PMx11.13-51	38	971	50	37	223	Huntsman (4-2)/ Minsum
1097	HXM-12-58	39	968	49	30	226	HuntsmXMinsum
1031	PMx11.10-1	40	963	49	28	227	Horizon (5-2)/Plateau
1071	HXR-1-23	41	957	48	39	223	HuntsmanXRise
1057	PMx11.13-58	42	950	47	35	223	Huntsman (4-2)/ Minsum
1040	PMx11.10-88	43	948	48	27	220	Horizon (5-2)/Plateau
1077	HXR-2-31	44	947	50	34	227	HuntsmanXRise
1088	HXM-10-39	45	935	48	33	226	HuntsmXMinsum
1019	PMx11.3-56	46	931	48	41	223	Huntsman(9-2)/174-7-13
1041	PMx11.12-5	47	931	54	32	225	Huntsman (5-1)/Horizon(4-1)
1069	PMx11.14-36	48	923	47	42	227	Huntsman (4-2)/ Rise (4-2)
1046	PMx11.12-20	49	921	49	36	221	Huntsman (5-1)/Horizon(4-1)
1066	PMx11.14-29	50	921	48	34	227	Huntsman (4-2)/ Rise (4-2)
1024	PMx11.4-47	51	921	49	24	224	Sunrise (2-1)/Huntsman
1039	PMx11.10-82	52	917	48	25	220	Horizon (5-2)/Plateau
1095	HXM-12-51	53	917	50	27	227	HuntsmXMinsum
1023	PMx11.4-32	54	915	49	31	226	Sunrise (2-1)/Huntsman
1078	HXR-2-32	55	915	-	28	227	HuntsmanXRise
1053	PMx11.13-21	56	912	50	38	223	Huntsman (4-2)/ Minsum
1052	PMx11.13-5	57	912	49	36	227	Huntsman (4-2)/ Minsum
1017	PMx11.3-49	58	911	47	33	223	Huntsman(9-2)/174-7-13
1044	PMx11.12-16	59	909	48	31	223	Huntsman (5-1)/Horizon(4-1)
1034	PMx11.10-38	60	909	48	24	222	Horizon (5-2)/Plateau
1068	PMx11.14-33	61	907	49	42	222	Huntsman (4-2)/ Rise (4-2)
1002	**Sunup**	62	907	49	29	225	**check**
1022	PMx11.4-16	63	894	49	35	222	Sunrise (2-1)/Huntsman
1050	PMx11.12-47	64	893	49	37	227	Huntsman (5-1)/Horizon(4-1)
1018	PMx11.3-54	65	893	49	34	226	Huntsman(9-2)/174-7-13
1006	**Horizon**	66	892	48	28	220	**check**
1070	PMx11.14-41	67	891	50	34	227	Huntsman (4-2)/ Rise (4-2)
1025	PMx11.4-71	68	887	47	31	223	Sunrise (2-1)/Huntsman
1076	HXR-2-29	69	875	50	36	224	HuntsmanXRise
1026	PMx11.4-77	70	874	47	36	221	Sunrise (2-1)/Huntsman
1093	HXM-12-39	71	870	50	35	224	HuntsmXMinsum
1072	HXR-1-52	72	869	49	37	222	HuntsmanXRise
1087	HXM-10-29	73	869	48	35	225	HuntsmXMinsum
1073	HXR-2-9	74	863	47	33	226	HuntsmanXRise
1020	PMx11.3-107	75	844	49	42	227	Huntsman(9-2)/174-7-13
1092	HXM-12-27	76	840	51	29	225	HuntsmXMinsum
1011	PMx11.3-15	77	834	48	31	226	Huntsman(9-2)/174-7-13

1058	PMx11.13-62	78	830	48	40	225	Huntsman (4-2)/ Minsum
1056	PMx11.13-57	79	818	48	38	223	Huntsman (4-2)/ Minsum
1064	PMx11.14-22	80	816	-	30	222	Huntsman (4-2)/ Rise (4-2)
1090	HXM-12-1	81	813	49	39	227	HuntsmXMinsum
1098	HXM-12-60	82	812	50	31	224	HuntsmXMinsum
1086	HXM-10-25	83	809	49	35	226	HuntsmXMinsum
1042	PMx11.12-6	84	806	48	34	226	Huntsman (5-1)/Horizon(4-1)
1100	HXM-12-142	85	806	49	36	224	HuntsmXMinsum
1062	PMx11.14-4	86	799	49	37	221	Huntsman (4-2)/ Rise (4-2)
1038	PMx11.10-75	87	778	49	37	220	Horizon (5-2)/Plateau
1094	HXM-12-44	88	777	49	31	226	HuntsmXMinsum
1009	**Snobird**	89	765	51	28	221	**check**
1075	HXR-2-26	90	763	48	39	227	HuntsmanXRise
1054	PMx11.13-45	91	761	51	35	224	Huntsman (4-2)/ Minsum
1007	**Plateau**	92	755	44	32	220	**check**
1012	PMx11.3-21	93	752	49	30	223	Huntsman(9-2)/174-7-13
1074	HXR-2-20	94	726	50	32	225	HuntsmanXRise
1008	**Minco**	95	721	-	38	220	**check**
1010	White seed landrace	96	714	49	44	223	PI 291364
1014	PMx11.3-41	97	711	49	34	227	Huntsman(9-2)/174-7-13
1015	PMx11.3-42	98	368	-	33	227	Huntsman(9-2)/174-7-13
1001	**Dawn**	99	333	-	43	227	**check**
1096	HXM-12-55	100	198	-	37	227	HuntsmXMinsum

Elite nursery:

Sixty elite breeding lines (including checks) were tested as replicated trial for seed yield potential under both dryland and irrigated condition. The lines ($F_{3:6}$) were planted under dryland in a 25 feet long 8-rows plot with 7.5 inches between rows (i.e. 5’ x 25’) at a seeding rate of 15 lbs/acre. Selection was based on uniformity and general agronomic appearance (mainly plant height measured from the soil surface to the tip of the spikes, flowering date measured as the number of days after planting Jan. 1 to when 50% of the emerged spikes had extruded anthers, straw strength measured using a scale of 1 to 10 with 1 being little to 10% lodging and 10 being 100 % lodged; grain yield, and grain volume weight). Result of the dryland and irrigated trials were presented below in Table 2 and Table 3, respectively.

Table 2. Proso millet elite nursery (preliminary yield trial) - 2015 (HPAL, **Dryland**). Trial was planted as replicated yield trial (RCBD) on June 17, 2015 and harvested on October 13, 2015. Yield and test weight (bushel weight) were reported at 12% grain moisture since grain moisture significantly varied among the plots. Names in **bold** are check varieties.

Name of line	Entry '15	Yield Rank	Yield (lbs/acre)	Bushel Weight (lbs/bu)	Plant Height (inch)	Heading (days after Jan.1)	Pedigree
PMx11.35-11	41	1	1713	51	35	227	Huntsman (5-1)/Horizon(4-1)
PMx11.32-91	50	2	1523	53	35	227	Huntsman (1-1)/ Sunup
PMx11.16-54	64	3	1486	51	33	226	Sunrise/PI346937
PMx11.35-3	34	4	1454	51	35	226	Huntsman (5-1)/Horizon(4-1)
PMx11.35-32	40	5	1433	50	32	227	Huntsman (5-1)/Horizon(4-1)
PMx11.35-19	37	6	1399	51	32	226	Huntsman (5-1)/Horizon(4-1)
PMx11.35-12	33	7	1392	50	34	226	Huntsman (5-1)/Horizon(4-1)
PMx11.35-15	35	8	1378	50	36	226	Huntsman (5-1)/Horizon(4-1)
PMx11.26-48	58	9	1340	51	35	227	Sunup (3-1)/Horizon
PMx11.35-44	39	10	1327	51	33	225	Huntsman (5-1)/Horizon(4-1)
PMx11.28-13	43	11	1325	51	31	225	Huntsman (1-3)/Dawn
PMx11.32-93	52	12	1325	51	33	227	Huntsman (1-1)/ Sunup
PMx11.26-20	57	13	1259	51	22	227	Sunup (3-1)/Horizon
PMx11.35-7	36	14	1258	52	36	226	Huntsman (5-1)/Horizon(4-1)
PMx11.35-27	38	15	1237	52	30	225	Huntsman (5-1)/Horizon(4-1)
PMx11.32-72	54	17	1216	51	29	227	Huntsman (1-1)/ Sunup
Huntsman	4	16	1216	53	29	223	**Check**
Sunup	2	18	1202	50	30	221	**Check**
PMx11.25-92	76	19	1188	50	36	226	Huntsman (1-1)/Plateau
PMx11.28-5	44	20	1185	50	31	224	Huntsman (1-3)/Dawn
PMx11.25-72	75	21	1181	50	33	227	Huntsman (1-1)/Plateau
PMx11.36-36	69	22	1173	48	33	219	Earlybird (4-3)/Plateau
PMx11.32-95	49	23	1172	51	31	227	Huntsman (1-1)/ Sunup
PMx11.16-70	66	24	1158	52	33	225	Sunrise/PI346937
PMx11.16-26	65	25	1150	50	34	226	Sunrise/PI346937
PMx11.34-22	73	26	1144	50	32	223	Huntsman (1-2)/Earlybird
PMx11.36-10	67	27	1139	52	35	223	Earlybird (4-3)/Plateau
PMx11.32-84	48	28	1125	48	34	227	Huntsman (1-1)/ Sunup
PMx11.26-40	59	29	1124	51	30	227	Sunup (3-1)/Horizon
PMx11.32-79	51	30	1115	51	35	226	Huntsman (1-1)/ Sunup
PMx11.28-23	46	31	1104	52	32	225	Huntsman (1-3)/Dawn
PMx11.34-36	72	32	1094	49	31	225	Huntsman (1-2)/Earlybird
Dawn	1	33	1084	50	33	218	**Check**
PMx11.26-29	60	34	1079	51	30	227	Sunup (3-1)/Horizon
PMx11.24-1	62	35	1073	52	33	218	Huntsman (1-2)/182-4-24
PMx11.27-68	63	36	1071	51	34	224	Huntsman (4-2)/174-7-13
PMx11.35-64	42	37	1065	53	38	227	Huntsman (5-1)/Horizon(4-1)

Plateau	7	38	1056	50	31	219	**Check**
PMx11.20-66	78	39	1053	48	34	221	177-8 (3-1)/Plateau (4-2)
PMx11.34-6	74	40	1046	48	30	223	Huntsman (1-2)/Earlybird
PMx11.31-78	56	41	1033	49	29	226	177-9-13 (1-1)/Horizon
PMx11.28-9	45	42	1029	52	31	223	Huntsman (1-3)/Dawn
5083_Tall	31	43	1002	51	32	226	
PMx11.39-20	70	44	999	51	34	227	177-9-13 (1-3)/182-4-24
Minco	8	45	998	51	31	219	**Check**
PMx11.28-37	47	46	995	54	32	225	Huntsman (1-3)/Dawn
PMx11.19-18	79	47	994	49	37	220	Sunup (4-1)/Plateau (4-1)
PMx11.32-67	53	48	991	52	31	227	Huntsman (1-1)/ Sunup
PMx11.31-1	55	49	988	51	32	227	177-9-13 (1-1)/Horizon
Sunrise	5	50	971	50	28	222	**Check**
PMx11.26-63	61	51	958	51	34	227	Sunup (3-1)/Horizon
PMx11.20-57	77	52	957	49	33	222	177-8 (3-1)/Plateau (4-2)
Snobird	9	53	950	48	32	221	**Check**
PMx11.34-40	71	54	944	52	36	224	Huntsman (1-2)/Earlybird
Earlybird	3	55	940	49	30	222	**Check**
PMx11.36-14	68	56	938	52	35	225	Earlybird (4-3)/Plateau
PMx11.19-20	80	57	928	49	30	218	Sunup (4-1)/Plateau (4-1)
PMx11.19-96	81	58	927	50	32	223	Sunup (4-1)/Plateau (4-1)
Horizon	6	59	875	53	33	221	**Check**
5025_Tall	32	60	857	50	33	220	
Mean			**1339**	**51**	**32**	**224**	
LSD (0.05)			**343**	**2**	**7**	**2**	
CV			**22**	**2.2**	**16**	**3**	

Table 3. Proso millet elite nursery (preliminary yield trial) - 2015 (HPAL, **Irrigated**). Trial was planted as replicated yield trial (RCBD) on June 17, 2015 and harvested on October 15, 2015. Yield and test weight (bushel weight) were reported at 12% grain moisture since grain moisture significantly varied among the plots. Names in **bold** are check varieties.

Variety	Entry '15	Yield Rank	Yield (lbs/acre)	Bushel Weight (lbs/bu)	Plant Height (inch)	Heading (days after Jan.1)	Pedigree
PMx11.26-32	22	1	2188	51	43	226	Sunup (3-1)/Horizon
PMx11.32-85	20	2	2094	51	37	226	Huntsman (1-1)/ Sunup
PMx11.32-79	51	3	2083	51	32	225	Huntsman (1-1)/ Sunup
524	16	4	1997	46	36	220	
PMx11.24-40	23	5	1992	51	39	220	Huntsman (1-2)/182-4-24
5098	17	6	1992	51	36	222	
PMx11.35-7	36	7	1962	52	34	227	Huntsman (5-1)/Horizon(4-1)
PMx11.23-52	27	8	1950	49	35	221	177-8 (3-1)/ Rise

PMx11.25-72	75	9	1943	51	38	226	Huntsman (1-1)/Plateau
PMx11.25-70	30	10	1928	52	34	227	Huntsman (1-1)/Plateau
PMx11.35-52	18	11	1926	52	35	226	Huntsman (5-1)/Horizon(4-1)
PMx11.26-20	57	12	1920	51	39	226	Sunup (3-1)/Horizon
PMx11.26-40	59	13	1919	52	35	226	Sunup (3-1)/Horizon
PMx11.35-3	34	14	1881	50	34	227	Huntsman (5-1)/Horizon(4-1)
PMx11.32-95	49	15	1878	52	29	226	Huntsman (1-1)/ Sunup
PMx11.35-19	37	16	1875	50	35	226	Huntsman (5-1)/Horizon(4-1)
PMx11.26-48	58	17	1844	52	38	225	Sunup (3-1)/Horizon
PMx11.35-15	35	18	1836	51	34	227	Huntsman (5-1)/Horizon(4-1)
PMx11.31-101	21	19	1825	51	39	225	177-9-13 (1-1)/Horizon
PMx11.39-27	28	20	1809	51	37	226	177-9-13 (1-3)/182-4-24
Plateau	7	21	1802	47	33	218	**Check**
Minco	8	22	1782	49	32	220	**Check**
Huntsman	4	23	1775	51	33	226	**Check**
PMx11.16-30	25	24	1771	52	34	226	Sunrise/PI346937
PMx11.32-84	48	25	1767	51	35	226	Huntsman (1-1)/ Sunup
PMx11.19-18	79	26	1757	51	38	221	Sunup (4-1)/Plateau (4-1)
PMx11.35-12	33	27	1757	51	31	227	Huntsman (5-1)/Horizon(4-1)
Horizon	6	28	1753	51	33	223	**Check**
5100	13	29	1747	50	39	222	
5016	12	30	1743	49	35	224	
PMx11.34-7	29	31	1743	51	35	226	Huntsman (1-2)/Earlybird
Snobird	9	32	1732	49	32	223	**Check**
PMx11.31-78	56	33	1723	51	38	224	177-9-13 (1-1)/Horizon
PMx11.35-27	38	34	1720	53	25	226	Huntsman (5-1)/Horizon(4-1)
PMx11.32-91	50	35	1717	52	38	226	Huntsman (1-1)/ Sunup
Sunrise	5	36	1705	51	36	222	**Check**
PMx11.28-52	19	37	1703	51	40	224	Huntsman (1-3)/Dawn
PMx11.16-54	64	38	1699	51	36	225	Sunrise/PI346937
PMx11.36-10	67	39	1693	52	32	223	Earlybird (4-3)/Plateau
PMx11.27-79	24	40	1681	52	36	225	Huntsman (4-2)/174-7-13
PMx11.36-3	26	41	1670	51	38	225	Earlybird (4-3)/Plateau
Sunup	2	42	1669	52	37	224	**Check**
Earlybird	3	43	1648	51	35	221	**Check**
PMx11.27-68	63	44	1639	52	33	224	Huntsman (4-2)/174-7-13
PMx11.28-23	46	45	1610	52	36	223	Huntsman (1-3)/Dawn
PMx11.32-93	52	46	1603	52	38	226	Huntsman (1-1)/ Sunup
PMx11.28-9	45	47	1584	51	35	224	Huntsman (1-3)/Dawn
177-9-13	11	48	1562	51	34	220	
5008	15	49	1547	51	34	220	
PMx11.31-1	55	50	1534	52	37	226	177-9-13 (1-1)/Horizon
PMx11.24-1	62	51	1523	51	35	218	Huntsman (1-2)/182-4-24

PMx11.28-13	43	52	1495	50	35	224	Huntsman (1-3)/Dawn
PMx11.34-40	71	53	1494	51	37	226	Huntsman (1-2)/Earlybird
5106wx	14	54	1493	52	33	221	
PMx11.20-57	77	55	1491	52	38	224	177-8 (3-1)/Plateau (4-2)
PMx11.39-20	70	56	1480	50	38	226	177-9-13 (1-3)/182-4-24
PMx11.28-5	44	57	1447	51	35	225	Huntsman (1-3)/Dawn
PMx11.34-36	72	58	1439	52	36	224	Huntsman (1-2)/Earlybird
Dawn	1	59	1352	52	35	220	**Check**
FarmerEntry	10	60	1178	51	35	217	Landrace from Austria
Mean			**1734**	**51**	**35**	**224**	
LSD (0.05)			**367**	**2**	**8**	**2**	
CV			**15**	**2**	**16**	**3**	

Variety trial:

Thirty advanced breeding lines (including checks), which included 13 lines ($F_{3:6}$) selected from elite nursery 2014, were tested as replicated trial for seed yield potential. The lines were planted in a 25 feet long 8-rows plot with 7.5 inches between rows (i.e. 5' x 25') at a seeding rate of 15 lbs/acre under dryland (no-till), dryland organic (tilled), and irrigated condition. Selection was based on uniformity and general agronomic appearance (mainly plant height measured from the soil surface to the tip of the spikes, flowering date measured as the number of days after planting Jan. 1 to when 50% of the emerged spikes had extruded anthers, straw strength measured using a scale of 1 to 10 with 1 being little to 10% lodging and 10 being 100 % lodged; grain yield, and grain volume weight). In addition, these lines were also evaluated at Akron, CO and near Rapid City in SD. Results of the three variety trials at the HPAL were presented in Table 4, Table 5, and Table 6, respectively.

Table 4. 2015 proso millet variety trial under dryland no-till at the High Plains Ag. Lab in Cheyenne Co. Trial was planted as replicated yield trial (RCBD) on June 17, 2015 and harvested on October 14, 2015. Yield and test weight (bushel weight) were reported at 12% grain moisture since grain moisture significantly varied among the plots. Names in **bold** are check varieties.

Variety	Entry '15	Yield Rank	Yield (lbs/acre)	Bushel weight (lbs/bu)	Plant Height (inches)	Heading (days after Jan.1)	Pedigree
Dawn	1	1	1595	51	28	220	**Check**
PMx11.26-32	22	2	1552	50	32	221	Sunup (3-1)/Horizon
PMx11.35-52	18	3	1532	51	33	222	Huntsman (5-1)/Horizon(4-1)
5098	17	4	1498	49	27	222	
Horizon	6	5	1497	51	35	220	**Check**
Huntsman	4	6	1495	48	34	221	**Check**
5008	15	7	1480	49	32	221	

PMx11.16-30	25	8	1429	48	30	221	Sunrise/PI346937
Minco	8	9	1415	49	34	221	**Check**
PMx11.27-79	24	10	1398	49	29	222	Huntsman (4-2)/174-7-13
PMx11.25-70	30	11	1385	50	28	222	Huntsman (1-1)/Plateau
177-9-13	11	12	1382	48	33	221	
5016	12	13	1373	50	35	221	
PMx11.31-101	21	14	1366	51	35	222	177-9-13 (1-1)/Horizon
PMx11.36-3	26	15	1359	46	31	220	**Check**
Plateau	7	16	1358	47	31	220	**Check**
Earlybird	3	17	1341	47	33	223	**Check**
PMx11.24-40	23	18	1339	47	31	222	Huntsman (1-2)/182-4-24
5106wx	14	19	1328	49	37	222	
524	16	20	1324	48	33	220	
PMx11.23-52	27	21	1305	46	34	221	177-8 (3-1)/ Rise
PMx11.28-52	19	22	1301	46	33	222	Huntsman (1-3)/Dawn
Sunrise	5	23	1293	48	33	222	**Check**
PMx11.32-85	20	24	1290	49	32	221	Huntsman (1-1)/ Sunup
Sunup	2	25	1280	48	26	221	**Check**
5100	13	26	1269	45	36	221	
Snowbird	9	27	1263	46	32	222	**Check**
PMx11.39-27	28	28	1263	47	38	221	177-9-13 (1-3)/182-4-24
FarmerEntry	10	29	1263	47	35	221	Landrace from Austria
PMx11.34-7	29	30	1208	46	33	220	Huntsman (1-2)/Earlybird
Mean			**1372**	**48**	**32**	**221**	
LSD at 5%			**288**	**4**	7	**2**	

Table 5. 2015 proso millet variety trial under dryland organic production condition at the High Plains Ag. Lab in Cheyenne Co. Trial was planted as replicated yield trial (RCBD) on June 21, 2015 and harvested on September 30, 2015. Yield and test weight (bushel weight) were reported at 12% grain moisture since grain moisture significantly varied among the plots. Names in **bold** are check varieties.

Variety	Entry '15	Yield Rank	Yield (lbs/acre)	Bushel weight (lbs/bu)	Plant Height (inches)	Heading (days after Jan.1)	Pedigree
PMx11.35-52	18	1	2072	53	33	221	Huntsman (5-1)/Horizon(4-1)
PMx11.26-32	22	2	1958	53	41	222	Sunup (3-1)/Horizon
PMx11.25-70	30	3	1943	51	25	221	Huntsman (1-1)/Plateau
5098	17	4	1912	53	36	220	
PMx11.32-85	20	5	1910	52	33	221	Huntsman (1-1)/ Sunup
PMx11.28-52	19	6	1868	53	30	220	Huntsman (1-3)/Dawn
PMx11.39-27	28	7	1763	52	32	219	177-9-13 (1-3)/182-4-24
PMx11.31-101	21	8	1756	54	37	219	177-9-13 (1-1)/Horizon
PMx11.24-40	23	9	1725	53	39	219	Huntsman (1-2)/182-4-24

524	16	10	1688	48	38	218	
Huntsman	4	11	1684	52	32	220	**Check**
PMx11.23-52	27	12	1660	50	36	219	177-8 (3-1)/ Rise
Snobird	9	13	1646	52	33	219	**Check**
PMx11.27-79	24	14	1612	53	36	221	Huntsman (4-2)/174-7-13
Earlybird	3	15	1601	51	31	219	**Check**
PMx11.16-30	25	16	1589	52	34	221	Sunrise/PI346937
Horizon	6	17	1566	51	36	219	**Check**
Sunup	2	18	1562	52	28	219	**Check**
PMx11.34-7	29	19	1544	52	32	220	Huntsman (1-2)/Earlybird
5100	13	20	1542	50	37	220	
5008	15	21	1462	52	37	218	
Sunrise	5	22	1440	52	28	219	**Check**
Dawn	1	23	1434	53	36	217	**Check**
Minco	8	24	1410	50	38	218	**Check**
PMx11.36-3	26	25	1285	50	34	221	Earlybird (4-3)/Plateau
Plateau	7	26	1271	49	33	218	**Check**
5016	12	27	1242	50	35	220	
177-9-13	11	28	1205	51	31	217	
5106wx	14	29	1140	50	32	219	
FarmerEntry	10	30	1081	53	30	214	Landrace from Austria
Mean			**1586**	**52**	**34**	**219**	
LSD at 5%			**344**	**3**	**3**	**1**	

Table 6. 2015 proso millet variety trial under irrigation at the High Plains Ag. Lab in Cheyenne Co. Trial was planted as replicated yield trial (RCBD) on June 25, 2015 and harvested on October 15, 2015. Yield and test weight (bushel weight) were reported at 12% grain moisture since grain moisture significantly varied among the plots. Names in **bold** are check varieties.

Variety	Entry '15	Yied Rank	Yield (lbs/acre)	Bushel weight (lbs/bu)	Plant Height (inch)	Heading (days after Jan.1)	Pedigree
PMx11.36-3	26	1	1942	45	32	225	Earlybird (4-3)/Plateau
5098	17	2	1764	45	30	224	
177-9-13	11	3	1751	46	28	220	
PMx11.24-40	23	4	1747	45	26	219	Huntsman (1-2)/182-4-24
Huntsman	4	5	1747	46	29	227	**Check**
5008	15	6	1736	46	32	221	
Snowbird	9	7	1735	46	31	222	**Check**
PMx11.34-7	29	8	1730	45	26	227	Huntsman (1-2)/Earlybird
Sunup	2	9	1726	45	35	224	**Check**

PMx11.23-52	27	10	1724	45	32	221	177-8 (3-1)/ Rise
Minco	8	11	1723	46	31	220	
PMx11.16-30	25	12	1716	46	26	224	Sunrise/PI346937
PMx11.27-79	24	13	1711	46	27	227	Huntsman (4-2)/174-7-13
PMx11.26-32	22	14	1705	46	29	226	Sunup (3-1)/Horizon
5016	12	15	1700	46	31	225	
Sunrise	5	16	1696	46	30	224	**Check**
PMx11.25-70	30	17	1696	45	28	227	Huntsman (1-1)/Plateau
Plateau	7	18	1693	45	31	218	**Check**
5106wx	14	19	1676	46	31	221	
Earlybird	3	20	1668	46	35	223	**Check**
524	16	21	1664	45	26	220	
5100	13	22	1662	46	27	226	
PMx11.32-85	20	23	1662	46	27	227	Huntsman (1-1)/ Sunup
PMx11.31-101	21	24	1653	46	29	225	177-9-13 (1-1)/Horizon
Horizon	6	25	1647	46	30	223	**Check**
PMx11.39-27	28	26	1644	46	29	225	177-9-13 (1-3)/182-4-24
PMx11.28-52	19	27	1619	46	26	225	Huntsman (1-3)/Dawn
FarmerEntry	10	28	1555	46	31	218	Landrace from Austria
PMx11.35-52	18	29	1549	46	28	227	Huntsman (5-1)/Horizon(4-1)
Dawn	1	30	1081	46	30	222	**Check**
Mean			**1677**	**46**	**29**	**223**	
LSD at 5%			**181**	**1**	**2**	**2**	

Germplasm evaluation:

A total of 78 genotypes from 24 different countries were evaluated in the field during 2015 at the High Plains Ag. Lab (Sidney) and Scottsbluff. Nine morpho-agronomic traits, which were evaluated were heading date, plant height, peduncle length, internode number, lodging, panicle length, grain shattering, 100 grain weight, and grains per panicle. Phenotypic data for all these traits were taken on randomly selected plants in the middle of row. Except for heading date, all the traits were recorded at the time of physiological maturity and after harvest. Data analysis is under progress and therefore no data is presented here.

Mapping genes and QTLs:

No genetic linkage map and QTL mapping for proso millet are available. Objectives of the present study were to (1) construct a genetic linkage map and (2) map and identify DNA markers linked of QTLs for morpho-agronomic traits. A total of 93 recombinant inbred lines derived from a single F_1 ('Huntsman' x 'Minsum') were genotyped with GBS-SNP markers and phenotyped for nine morpho-agronomic traits in the field during 2013 and 2014 at Scottsbluff and Sidney, NE. IciMapping v.4.0.6.0 was used for genetic linkage map construction and QTL mapping. The RILs were significantly different for many traits and several traits showed genotype x environment interactions. A total of 833 GBS-SNP markers formed 18 major and 84 minor linkage groups, whereas 519 markers remained ungrouped. A total of 117 GBS-SNP markers on the 18 major linkage groups spanning a genome length of 2137 cM of proso millet with an average distance of 18 cM between markers (Figure 1). The length and number of markers in each of the 18 major linkage groups ranged from 54.6 cM to 236 cM and four to 12, respectively. A total of 17 QTLs for seven morpho-agronomic traits were detected on 14 linkage groups, which explained 13.2 to 34.7% phenotypic variance (Table 7). The genes (QTLs) for these morpho-agronomic traits were identified and mapped on proso millet chromosomes (Fig.1). The DNA markers flanking the QTLs were identified, which would be useful in marker-assisted selection of these traits. This is the first genetic linkage map and QTL mapping in proso millet, which would be useful for further genetic analysis and map-based cloning the genes.

Fig.1 Genetic linkage map of proso millet with QTLs identified using 93 recombinant inbred lines of 'Huntsman X Minsum' which were evaluated at Scottsbluff (SB) and Sidney (SY) location in 2013 and 2014. GBS-SNP marker names and QTL names are on right hand side and genetic distances (cM) between the markers are on left hand side. QTL location between marker interval is indicated by arrow. The segregation distorted markers were underlined with red lines.

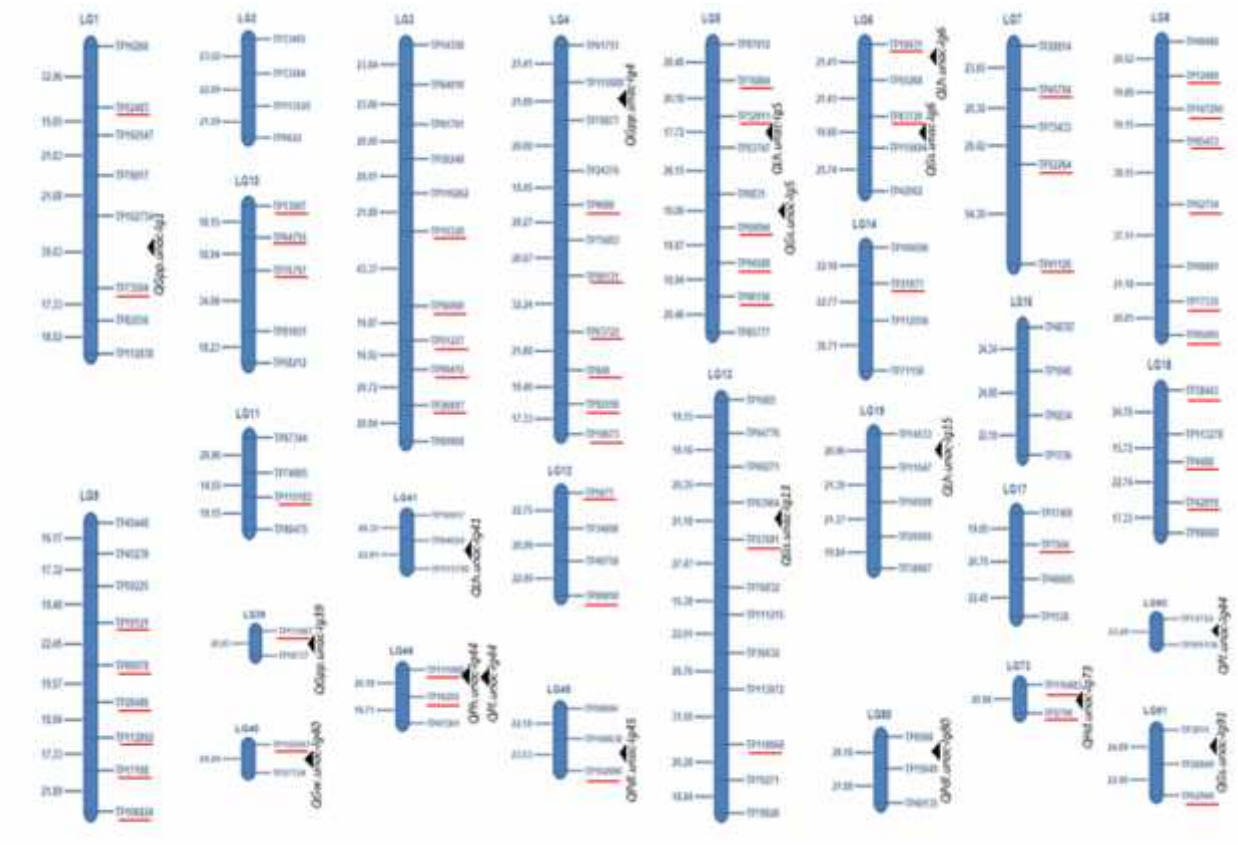


Table 7. Summary of QTLs identified by composite interval mapping for seven morpho-agronomic traits in 93 recombinant inbred lines of 'Huntsman X Minsum' which were evaluated at Scottsbluff (SB) and Sidney (SY) location in 2013 and 2014.

Trait	QTL name[¶]	LG	Location & Year[$]	Flanking markers	Interval [#] (cM)	LOD	PVE[¥] (%)	Additive effect
Plant height	***QPh.unac-lg44***	44	SB13	TP111068 - TP16292	20.18	2.92	13.65	0.883
Peduncle length	***QPdl.unac-lg80***	80	SY13	TP8566 - TP15649	20.18	2.87	13.27	0.191
	QPdl.unac-lg45	45	AVG	TP100630-TP102086	23.53	3.37	23.92	0.180
Lodging	*QLh.unac-lg5*	5	SB13	TP32911 - TP53747	17.72	2.65	34.77	695.16
	QLh.unac-lg6	6	SY14	TP18431 - TP55268	21.41	3.20	14.66	-568.02
	QLh.unac-lg15	15	AVG	TP14533 - TP11547	20.96	3.03	14.22	-295.29
	QLh.unac-lg41	41	AVG	TP64024 - TP111750	22.91	2.55	16.78	320.80
Panicle length	***QPl.unac-lg44***	44	SB13	TP111068 - TP16292	20.18	3.61	16.60	0.219
	QPl.unac-lg92	92	SY13	TP72722 - TP101136	23.20	2.62	15.79	0.116
Grain shattering	***QGs.unac-lg5***	5	SY14	TP6831 - TP69094	19.06	3.98	21.57	3.846
	QGs.unac-lg6	6	SY14	TP83720 - TP115604	18.68	3.11	14.22	3.046
	QGs.unac-lg13	13	SB14	TP63964 - TP23581	21.18	3.59	14.99	2.933
	QGs.unac-lg91	91	SB14	TP3611 - TP28849	24.89	3.65	17.15	3.094
100 grain weight	***QGw.unac-lg40***	40	AVG	TP102597 - TP27724	24.24	3.43	22.47	-0.015
Grains per panicle	***QGpp.unac-lg1***	1	AVG	TP102734 - TP73504	39.03	2.97	14.21	-20.45
	QGpp.unac-lg4	4	SY14	TP115888 - TP78877	21.89	2.89	21.49	65.287
	QGpp.unac-lg39	39	SY13	TP113467 - TP58737	20.93	2.80	18.53	-31.72

[¶]QTLs indicated in bold were detected by both (SMA and CIM) methods.

$: AVG= QTL detected on average mean data of all four environments

#: Distance in centimorgan between flanking markers

¥: Phenotypic variance explained

Grain Legume Crops for western Nebraska: Pea and Fenugreek

Dipak K. Santra, Allison Hazen, and Vernon Florke
Alternative Crops Breeding Program, Panhandle Research & Extension Center,
University of Nebraska – Lincoln, Scottsbluff, NE 69361

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 recently. There has been new interest for pea production due to new international export market in for human food. In 2015, 22 pea cultivars from five commercial seed companies and one university were tested at five different trials (Scotts Bluff dry & irri, Cheyenne Co., Pekins Co., and Lincoln Co.) across western Nebraska.

Methods:

Trial were planted and managed following standard agronomic recommendation for pea with minor modification depending on trial condition, availability of chemicals and machinery. Seeding rate for dryland and irrigated trials were 350,000 live seeds/acre and 435,000 live seed/acre, respectively. Seeds of each plot for all trials were inoculated with granular inoculum right before planting. Plot design for each trial was random complete block design (RCBD) with four replications. Target dates for planting were during last week of March and first week of April and during second half of July for harvesting. Specific dates for each trial varied depending on weather and schedule of the co-operating growers. Trials were planted in a 25 feet long 8-rows plot with 7.5 inches between rows (i.e. 5’ x 25’) at a seeding depth of approximately 2 inches. Five agronomic data related to harvestable seed yield were recorded throughout. Days to flower (DTF) was recorded as number of days counted from January 1 when 20% of plants have at least one open flower. Similarly days to end of flower (EOF) was recorded when 90% plants at each plot completed flowering. Trials were inspected at 2-3 days interval for flowering data. Duration of flowering period of pea variety is important since longer duration varieties would have higher yield potential under mild production conditions in June (like in 2015) compared to short duration varieties and vice versa. Flowering period was the difference between days to flower and days to end of flower. Maximum plant height was measured height of perfectly erect plants and it was taken gathering bunch of plants from center of plot and stretch up to measure the height from base of the plant to top. Second plant height was measured at harvest to determine reduction of plant height during combine. Minimum reduction is desirable for easy combining. Lodging (1=perfectly erect, 5=horizontal) was recorded as % of plants at each plots had a scale of 3 or lower. Trials were harvested using small-plot combine (Winter Steiger Delta). Seed weight/plot, test weight, and moisture at harvest were recorded from the combine. Yield and test weight (bushel weight) were reported at 10% grain moisture since grain moisture significantly varied among the plots.

Results:

Following tables showed 2015 results of the trial at the HPAL, across locations in western Nebraska, and three years' average of the trials at the HPAL.

Table 1 showed 2015 trial result at the HPAL. Average seed yield was 14 bu/acre ranged from 10 bu/acre (Navarro) to 18 bu/acre (SW Midas). Average test weight was 59 lbs/bu with ranged from 59 lbs/bu – 61 lbs/bu. Varieties varied significantly in seed weight. Thousand seed weight ranged from 184 g (Navarro) to 261 g (Montech 4152). On an average flowering was completed in 12 days but the duration varied from 7 days (CDC Saffron) to 17 days (Mystique). Maximum plant height ranged from 24 inches (CDC Saffron) to 38 inches (CDC Amarillo) with an average of 32 inches. However, there was significant height reduction when measured at harvest. Plant height at harvested averaged 18 inches ranged from 24 inches (CDC Amarillo) to 14 inches (SW-Midas and Navarro). Significant lodging was due to hail storm few days before harvesting, which caused significant yield loss.

Table 2 showed the results averaged over the locations across western Nebraska. Average seed yield was 23 bu/acre ranged from 20 bu/acre (Navarro) to 27 bu/acre (Durwood). Average test weight was 62 lbs/bu with ranged from 61 lbs/bu – 64 lbs/bu. Varieties varied significantly in seed weight. Thousand seed weight ranged from 210 g (AC Earlystar) to 240 g (Montech 4152). Plant height at harvested averaged 20 inches ranged from 15 inches (SW Midas) to 24 inches (Durwood).

Table 3 showed three years average of pea variety testing under dryland at the HPAL during 2013 – 2015. Nine of 22 varieties were common across years. Average seed yield of the nine common varieties was 30 bu/acre ranged from 26 bu/acre (Navarro) to 33 bu/acre (Agassiz). Average test weight was 59 lbs/bu with ranged from 57 lbs/bu – 60 lbs/bu. Eight of nine varieties were not significantly different in seed yield based on statistic (LSD).

Conclusions:

- Eight varieties have seed yield potential of 27 bu/acre to 33 bu/acre based on last three years of testing at the HPAL in Cheyenne Co. only. The varieties are Agassiz, Salamanca, Spider, DS Admiral, Bridger, Nette, SW Midas, and Jetset. Therefore, this result is applicable for southern Panhandle. Tame result may not be expected at other locations where climate (especially temp. and rainfall) could be significantly different from southern Panhandle.
- Pea varieties seed yield and other related characteristics varied significantly across years and locations throughout western Nebraska. Trials in Box Butte Co. during last two years was lost due to weather. The 2015 was the first year for trials in Perkins Co. and Lincoln Co. Therefore, at least two more years of testing would be necessary before preparing a list of high yielding pea varieties for western Nebraska.

Table 1. Nebraska Pea Variety Test - 2015 (Cheyenne Co., Dryland). Trial was planted as replicated yield trial (RCBD) on April 6, 2015 and harvested on July 24, 2015. Yield at 10% moisture basis and 1 bu = 60 lbs. Flowering days counted from January 1.

Brand	Variety	Entry'15	Yield rank	Yield (bu/a)	Bushel weight (lbs/bu)	1000 seeds wt (g)	Days to flower	Days to end of flower	Flowering period (days)	Max plant height (inches)	Plant height at harvest (inches)	Lodging %
Pulse USA	SW Midas	12	1	18	59	222	166	180	15	29	14	53
Univ. Saskatchewan	CDC Meadow	19	2	17	61	226	164	179	15	32	19	41
Pulse USA	Durwood	17	3	17	60	246	164	178	14	36	22	20
Great Northern Ag.	Spider	1	4	16	61	253	165	180	15	33	19	46
Meridian Seed	Jetset	6	5	16	60	235	165	174	9	29	20	35
Legume Logic	Trapeze	10	6	16	60	240	165	180	15	33	16	61
Univ. Saskatchewan	CDC Amarillo	21	7	16	60	245	169	180	11	38	24	6
Meridian Seed	AAC Carver	8	8	16	60	248	165	175	10	35	20	51
Pulse USA	Nette 2010	14	9	15	61	228	164	174	10	31	18	34
Meridian Seed	AC Agassiz	5	10	15	59	240	168	181	14	31	20	28
Univ. Saskatchewan	CDC Saffron	20	11	15	58	252	168	176	7	24	23	13
Meridian Seed	AC Earlystar	7	12	15	59	217	164	180	16	36	15	89
Arrowseed	Montech 4152	23	13	14	59	261	164	177	14	31	20	26
Pulse USA	DS-Admiral	11	14	14	59	237	165	179	14	33	18	50
Great Northern Ag.	Bridger	2	15	14	60	240	164	175	11	32	22	48
Pulse USA	Abarth	13	16	13	60	245	164	175	11	34	19	53
Pulse USA	Mystique	16	17	13	58	244	165	181	17	36	20	35
Pulse USA	Viper	18	18	12	58	226	163	174	11	31	16	63
Legume Logic	Hyline	9	19	12	60	252	165	180	16	31	13	86
Great Northern Ag.	Salamanca	4	20	12	59	253	165	175	10	35	19	56
Arrowseed	Montech 4193	22	21	11	60	244	166	175	9	31	18	58
Great Northern Ag.	Navarro	3	22	10	60	184	162	174	12	28	14	81
Mean				**14**	**59**	**238**	**165**	**177**	**12**	**32**	**18**	**47**
LSD (0.05)				**4**	**2**	**39**	**1**	**3**	**3**	**6**	**4**	**31**

Table 2. Nebraska Pea Variety Test.Dryland - 2015 across dryland locations (Cheyenne CO., Scotts Bluff Co., Perkins Co., and Lincoln Co.). Yield at 10% moisture basis and 1 bu = 60 lbs. Flowering days counted from January 1.

Brand	Variety	15 Entry	Yield rank	Yield (bu/a)	Bushet weight (lbs/bu)	1000 seed weight (g)	Plant Height at harvest (inch)
Pulse USA	Durwood	17	1	27	62	226	26
Meridian Seed	AAC Carver	8	2	27	62	221	22
Meridian Seed	Jetset	6	3	26	62	220	20
Univ. Saskatchewan	CDC Saffron	20	4	26	62	233	19
Univ. Saskatchewan	CDCAmarillo	21	5	25	62	229	26
Great Northern Ag.	Salamanca	4	6	25	62	239	23
Pulse USA	Mystique	16	7	25	62	223	23
Univ. Saskatchewan	CDC Meadow	19	8	25	62	220	20
Great Northern Ag.	Spider	1	9	24	62	233	19
Arrowseed	Montech 4152	23	10	24	64	240	22
Pulse USA	Nette 2010	14	11	24	63	223	18
Pulse USA	SW Midas	12	12	23	61	223	15
Pulse USA	Abarth	13	13	23	62	236	21
Pulse USA	DS-Admiral	11	14	23	61	219	17
Great Northern Ag.	Bridger	2	15	23	61	220	23
Legume Logic	Hyline	9	16	22	62	230	17
Meridian Seed	AC Earlystar	7	17	22	62	210	20
Legume Logic	Trapeze	10	18	22	61	230	17
Arrowseed	Montech 4193	22	19	22	61	228	19
Pulse USA	Viper	18	20	21	61	214	17
Meridian Seed	AC Agassiz	5	21	20	62	220	21
Great Northern Ag.	Navarro	3	22	20	62	232	16
Mean				**23**	**62**	**225**	**20**
LSD (0.05)				**4**	**1**	**18**	**3**

Table 3. Three years averages of Pea Variety Test under dryland at the High Plains Ag. (Cheyenne CO.)Yield at 10% moisture basis and 1 bu = 60 lbs.

Brand	Variety	Prmt Entry	Yield Rank	Yield (bu/a)	Bushel weight (lbs/bu)
Meridian Seeds	Agassiz	6	1	33	59
Great Northern Ag.	Salamanca	3	2	32	58
Legume Logic	Spider	5	3	32	60
Pulse USA	DS Admiral	9	4	31	59
Legume Logic	Bridger	4	5	30	60
Pulse USA	Nette	11	6	29	60
Pulse USA	SW Midas	12	7	28	59
Meridian Seeds	Jetset	7	8	27	59
Great Northern Ag.	Navarro	2	9	26	57
Mean				**30**	**59**
LSD (0.05)				**7**	**4**

Fenugreek as potential medicinal crop

Goal of the project is to establish fenugreek as a new alternative crop in western Nebraska. Fenugreek belongs to legume and is capable of nodule formation for fixing biological N into soil. It seems that Rhizobium bacteria present in western Nebraska crop field is capable of nodule formation in fenugreek (Fig.1).

Fig.1: Healthy nodules on roots of fenugreek plants from the trial at Scottsbluff.

Method:

In 2015 60 fenugreek varieties from 175 global germplasm, which were selected over last 3 years for seed yield potential and agronomic adaptability were tested for seed yield under irrigation. The trial were planted in a 25 feet long 8-rows plot with 7.5 inches between rows (i.e. 5' x 25') at a seeding rate of 24 lbs/acre. Plot design for each trial was random complete block design (RCBD) with four replications. Trial was planted on May 18, 2015 at seeding depth of approximately 0.5 -0.75 inches under irrigation. The trial was harvested on October 12, 2015 using small-plot combine (Winter Steiger Delta). Seed weight/plot, test weight, and moisture at harvest were recorded from the combine. Yield and test weight (bushel weight) were reported at 10% grain moisture since grain moisture significantly varied among the plots (Table 4). Many of these 60 varieties were also tested during 2013 and 2014. Average seed yield of thirteen common varieties was shown in Table 5.

Table 4. 2015 Fenugreek seed yield trial at the High Plains Ag. Lab in Cheyenne Co. under irrigation. **Amber** and **Tristar** are the only two varieties (developed by Agri-Canada as forage) publicly available in North America are in bold.

Variety	Country	Yield (lbs/a)	Yld. Rank
PI302449	India	1255	1
PI426974	Pakistan	1197	2
PI164507	India	1119	3
PI269992	Pakistan	1109	4
PI515953	Iran	1099	5
PI141728	Iran	1093	6
PI183911	Unknown	1061	7
PI244060	Yemen	1028	8
PI208465	Nepal	1026	9
Amber	Canada	1009	10
PI613629	Morocco	1003	11
PI173973	Turkey	1000	12
PI568214	Turkey	982	13
PI617079	Bulgaria	980	14
PI543073	Pakistan	974	15
PI557489	Turkey	974	16
PI639185	Armenia	962	17
PI181814	Syria	954	18
PI195853	Egypt	944	19
PI617080	Bulgaria	942	20
PI194019	Ethiopia	930	21
PI164180	India	930	22
PI381062	Iran	920	23
PI138953	Iran	918	24

PI171872	Turkey	914	25
PI199264	Greece	914	26
PI164141	India	908	27
PI141730	Iran	908	28
PI138954	Iran	898	29
PI543072	Pakistan	894	30
PI141725	Iran	890	31
PI381061	Iran	888	32
PI568215	Turkey	886	33
PI222841	Iran	882	34
PI613630	Morocco	878	35
PI237564	Italy	876	36
PI180012	India	866	37
PI164402	India	858	38
PI204527	Turkey	846	39
PI141724	Iran	846	40
PI164625	India	834	41
Tristar	Canada	832	42
PI567879	Turkey	830	43
PI268434	Afghanistan	826	44
PI173820	Turkey	826	45
PI617077	Bulgaria	818	46
PI253996	Afghanistan	814	47
PI179057	Turkey	812	48
PI426970	Pakistan	810	49
PI302979	Spain	796	50
PI532864	Pakistan	791	51
PI194017	Ethiopia	781	52
PI170834	Turkey	739	53
PI203151	Jordan	699	54
PI179058	Turkey	601	55
PI183425	India	587	56
PI613632	Australia	583	57
PI141728	Iran	567	58
PI167246	Turkey	555	59
PI628786	Nepal	464	60
	Mean	**885**	
	LSD (0.05)	**286**	

Table 4. Two or three years average seed yield of 13 fenugreek varieties tested at the HPAL and Scottsbluff under irrigation during 2013 to 2015**Amber** and **Tristar** are the only two varieties (developed by Agri-Canada as forage) publicly available in North America are in bold.

Variety	Country	09 Ori. Entry	Years tested	No. of Yrs tested	Yld. Rank	Av.Yield (lbs/a)
PI302449	India	160	14-'15	2	1	1782
PI141725	Iran	54	13-'15	3	2	1552
PI141728	Iran	51	13-'15	3	3	1495
PI141724	Iran	55	13-'15	3	4	1460
PI426970	Pakistan	118	14-'15	2	5	1442
PI543073	Pakistan	113	14-'15	2	6	1425
Tristar	**Canada**	**V-2**	**13-'15**	**3**	**7**	**1354**
PI183911	Unknown	24	14-'15	2	8	1349
PI138954	Iran	59	13-'15	3	9	1330
PI567879	Turkey	133	14-'15	2	10	1310
Amber	**Canada**	**V-1**	**13-'15**	**3**	**11**	**1188**
PI181814	Syria	21	14-'15	2	12	1152
PI557489	Turkey	112	14-'15	2	13	1115

Conclusion:

- Fenugreek seems to be adapted in western Nebraska and could be a new highly valuable medicinal crop.
- Several high yielding lines were developed and had higher seed yield compared to ‘Tristar’ and ‘Amber’, two publicly available fenugreek varieties in North America. All these high seed yielding varieties were originally from India, Iran and Pakistan. This is not surprised since fenugreek was originated in that region of Asia.

Evaluation of Sunflower Hybrids for Western Nebraska

Dipak K. Santra, Vernon Florke, and Allison Hazen.
Alternative Crops Breeding Program, Panhandle Research & Extension Center,
University of Nebraska – Lincoln, Scottsbluff, NE 69361

There has been some change in sunflower seed industry. Several big companies started evaluating their sunflower hybrids by themselves. In 2015, we evaluated 10 hybrids of oil type (Croplan and Nuseed) and 2 hybrids of confection types (CHS) were tested at six different trials (dryland and irrigated production conditions) throughout western Nebraska. Results of the trials at the HPAL are presented here. Trials were planted in a 25 feet long 4-rows plot with 30 inches between rows (i.e. 10' x 25') at a plant population of 17,500/acre for dryland oil and irrigated confection whereas 22,000/acre for irrigated oil trials. Flowering date was measured as the number of days after planting Jan. 1 to when 50% of the plot had heads with 50% opened flower. Before harvest plant population for every rows were counted and plant height was measured from the soil surface to the tip of the spikes. Only two or four rows were harvested. Seed weight/plot, test weight, and moisture at harvest were recorded from the combine (Winter Steiger Delta small plot combine). Yield and test weight (bushel weight) were reported at 10% grain moisture since grain moisture significantly varied among the plots. Plant population counted before harvest was significantly lower than target population. At the HPAL, three sunflower trials, which were conducted in 2015 were: (1) oil type under dryland, (2) oil type under irrigation, and (3) confection type under irrigation and the results were presented in Tables 1, 2 and 3, respectively.

Table 1. 2015 Nebraska sunflower hybrid (oil) testing under dryland at the High Plains Ag. Lab (near Sidney, NE) in Cheyenne Co. Trial was planted as replicated yield trial (RCBD) with four replications on July 1, 2015 and harvested on November 16, 2015. The target population was 17,500 plants/acre. Yield reported below are as it is (plant population was not accounted for) and adjusted based on target population.

Brand	Hybrid	Oil Type*	Yield (lbs/a)	**Adj. Yield (lbs/a)	Bushel weight (lbs/bu)	Flowering (days after Jan.1)	Plant height (inch)	Population (plants/a)
Croplan	545 LC	NS	1046	1053	23	232	60	17163
Croplan	549 CL	HO	923	943	22	228	66	17511
Croplan	553 CL	HO	939	922	17	231	66	17947
Croplan	458 E	HO	980	910	22	231	64	19690
Croplan	432 E	NS	890	858	17	225	60	19428
Mean			**955**	**937**	**20**	**229**	**63**	**18347**
LSD§ (0.05)			**297**	**380**	**1**	**2**	**3**	**4590**

**NS = NuSun; HO - High Oleic; T = Traditional*

**Adjusted for 10% moisture and plant population of 22,000/acre

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

Previous crop: Winter wheat; Fertilizer: 50 lbs N per acre;
Herbicide: 2 Pints Prowl H2O, 2.5 oz Spartan.

Table 2. 2015 Nebraska sunflower hybrid (oil) Testing under irrigation at the High Plains Ag. Lab (near Sidney, NE) in Cheyenne Co. Trial was planted as replicated yield trial (RCBD) with four replications on June 13, 2015 and harvested on November 16, 2015. The target population was 22,000 plants/acre. Yield reported below are as it is (plant population was not accounted for) and adjusted based on target population.

Brand	Hybrid	*Oil Type	Yield (lbs/a)	**Adj. Yield (lbs/a)	Bushel weight (lbs/bu)	Flowering (days after Jan.1)	Plant height (inch)	Population (plants/a)
Nuseed	NHK 12M054	HO	595	2068	26	227	52	6883
Croplan	432 E	NS	621	2047	20	223	51	6708
Nuseed	NHK 12M055	HO	659	1987	26	228	50	7319
Nuseed	Hornet	HO	652	1818	26	230	57	8015
Croplan	545 LC	NS	659	1657	26	229	58	9148
Croplan	549 CL	HO	619	1603	25	224	70	8538
Croplan	553 CL	HO	615	1563	21	231	63	8712
Nuseed	Falcon	NS	669	1545	25	228	56	9496
Croplan	458 E	HO	611	1471	25	228	55	9583
Nuseed	Camoro II	NS	559	1399	26	227	59	8886
Mean			**625**	**1715**	**25**	**227**	**57**	**8328**
LSD[§] (0.05)			**228**	**764**	**1**	**2**	4	**1795**

**NS = NuSun; HO - High Oleic; T = Traditional*
**Adjusted for 10% moisture and plant population of 22,000/acre
[§] *Least Square Difference. Two varieties are different if the trait value differs by the LSD*
Previous crop: Winter wheat; Fertilizer: 50 lbs of ammonium sulfate per acre;
Herbicide: 2 Pints Prowl H2O, 2.5 oz Spartan.

Table 3. 2015 Nebraska sunflower hybrid (confection) testing under irrigation at the High Plains Ag. Lab (near Sidney, NE) in Cheyenne Co. Trial was planted as replicated yield trial (RCBD) with four replications on June 13, 2015 and harvested on November 16, 2015. The target population was 17,500 plants/acre. Yield reported below are as it is (plant population was not accounted for) and adjusted based on target population.

Brand	Hybrid	Yield (lbs/a)	*Adj. Yield (lbs/a)	Bushel weight (lbs/bu)	Flowering (days after Jan.1)	Plant Height (inch)	Population (plants/a)	Seed Size >22/64 %	Seed Size >20/64 %
CHS	RH 1130 EX	839	2358	19	234	57	6534	69	12
CHS	RH 609 CLP	610	1708	19	231	55	6447	77	7
Mean		**725**	**2033**	**19**	**233**	**56**	**6490**	**73**	**10**
LSD[§] (0.05)		**-**	**-**	**-**	**6**	**16**	**3276**	**8**	**-**

**NS = NuSun; HO - High Oleic; T = Traditional*
**Adjusted for 10% moisture and plant population of 17,500/acre
[§] *Least Square Difference. Two varieties are different if the trait value differs by the LSD*

Breeding Small Grains For Western Nebraska

P. Stephen Baenziger*, Devin Rose, Bob Graybosch, Dipak Santra, Jeff Bradshaw, Gary Hergert, Greg Kruger, Stephen Wegulo, and Gary Hein
* Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE 68583-0915

Background:

Small grains (winter wheat, winter triticale, and winter barley) are important crops in western Nebraska and provide growers with consistent yields and crop choices. While winter wheat is by far the most important small grain in western NE, its uses are evolving and there are opportunities for increasing the acreage of winter triticale and barley. Winter wheat is mainly used as a grain crop, but recently it is also used as a "flex" crop where wheat is planted and then depending upon the economics and wheat crop conditions, it may proceed to grain harvest or used as a cover crop before another crop. With the droughts that have occurred in western Nebraska, forage triticale can provide annual forage crop that can supplement other sources of forage. Winter barley and triticale have a place in cover crops. In addition, winter barley is immune to karnal bunt which could cause serious economic losses and major marketing changes.

Experiments at HPAL:

2015 was s a difficult year. We lost most of our barley plots and many of our triticale plots due to winterkill. Some of the wheat also winterkilled. The winterkill was due to drought in parts of western NE, but also due to extreme temperature fluctuations. Basically the crop broke dormancy due to high temperatures, started to regrow, and then was frozen. Each reqrowth depleted the plants reserves and eventually the plant had nothing left so it died. In addition, we were delayed by rains at harvest. The rains allowed the weeds to grow especially in our thin stands due to winterkilling. So the harvest was one of getting what you could, leaving what was not critical, and then finishing up just as the rain moved back in again. All in all, a year that will not be missed. The data from the elite trial at Sidney (and form the other testing sites) is on page 2.

In 2015, we again planted all of preliminary observation, intermediate, and elite nursery trials for hard winter wheat, winter triticale, and winter barley at HPAL. We also planted the majority of our F_3 segregating wheat bulks at HPAL so that we could see how they perform under western NE conditions where most of wheat lines are grown and as a back-up should something catastrophic happen for our main breeding site at Mead, NE. In addition, Dr. Santra planted the 2015 winter triticale forage trials. With the new research farm at Grant, NE, we temporarily moved our F_3 segregating wheat bulks to that location in 2015. It remains to be seen if they will stay at Grant, alternate with Grant and Sidney, or return to Sidney. However they are back in Sidney for 2016.

As part of our triticale effort, we have a small forage trial grown and harvested by Dr. Santra. The data can be found on page 3.

In addition, a new cultivar was released, NE10589 which will be sold as Husker Genetics Brand 'Ruth' (please see http://agronomy.unl.edu/Baenziger/NE10589SignedRelease.pdf) for its full description.

2015 Elite Wheat Trial											
	Mead	Linc+fung	Linc.	C. Center	N. Platte	McCook	**Grant**	Sidney	Alliance	**Avearge**	**Rank**
	Yield	Yield	Yield	Yield	Yield	Yield	**Yield**	Yield	Yield	**Yield**	
	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	**(bu/a)**	(bu/a)	(bu/a)	**(bu/a)**	
name	yb_m15	yb_lim15	yb_l15	yb_cc15	yb_np15	yb_mc15	**yb_grd15**	yb_s15	yb_al15		
WESLEY	17.1	44.5	25.0	17.4	43.4	27.2	**52.4**	37.9	34.1	**33.22**	**43**
OVERLAND	19.7	50.0	27.2	28.1	43.8	37.1	**55.9**	38.7	30.0	**36.72**	**32**
NE06545	29.2	62.3	35.7	18.9	38.9	34.8	**51.6**	37.1	29.1	**37.51**	**30**
NE09517	19.1	44.1	24.2	32.2	45.4	30.2	**48.7**	34.8	34.4	**34.79**	**38**
NE09521	22.2	53.9	39.1	27.5	47.6	33.9	**52.8**	39.4	34.5	**38.99**	**19**
NE10478	26.1	63.7	35.2	28.8	39.7	28.0	**53.3**	40.1	32.6	**38.61**	**21**
NE10507	25.9	44.6	29.5	22.2	38.8	38.2	**44.2**	34.4	20.2	**33.11**	**44**
NE10589	25.9	69.6	37.7	38.9	42.8	31.6	**55.0**	41.5	39.0	**42.44**	**6**
NE10683	16.9	47.9	21.0	11.7	37.0	32.9	**41.1**	23.6	21.1	**28.13**	**58**
LCH13NEDH-3-31	25.8	57.9	31.3	26.1	50.1	35.0	**58.0**	42.6	37.9	**40.52**	**14**
NW07505	10.2	52.3	15.0	14.3	38.2	35.9	**55.8**	42.9	35.2	**33.31**	**42**
NW11511	18.3	59.8	28.2	28.8	45.8	31.5	**43.4**	32.2	24.3	**34.70**	**39**
NI12702W	30.4	61.4	52.1	30.5	52.8	38.1	**45.0**	33.1	28.4	**41.31**	**9**
NI13706	36.5	65.9	41.2	27.4	47.0	31.5	**46.5**	28.8	25.0	**38.87**	**20**
NI04421	22.8	53.9	33.2	30.4	40.4	37.0	**51.7**	34.2	35.9	**37.72**	**29**
Settler CL	19.3	49.9	22.2	17.0	35.2	33.1	**49.7**	27.1	27.5	**31.22**	**52**
NE12429	16.9	59.3	20.6	22.0	32.5	36.7	**51.0**	29.3	26.4	**32.74**	**48**
NE12443	28.7	56.1	40.1	31.1	41.7	41.9	**48.8**	33.3	23.8	**38.39**	**25**
NE12444	25.9	55.8	35.0	18.0	19.3	27.6	**40.5**	22.0	42.3	**31.82**	**50**
NE12488	18.3	49.6	27.3	25.0	31.3	33.4	**49.6**	24.8	19.4	**30.97**	**53**
NE12561	31.3	52.2	35.9	36.0	48.2	29.9	**46.6**	38.0	27.5	**38.40**	**23**
NE12571	21.0	57.9	23.4	23.5	37.7	38.6	**52.4**	35.3	30.9	**35.63**	**35**
NE12589	30.1	62.9	35.8	26.5	46.8	30.6	**53.9**	38.3	31.0	**39.54**	**18**
NE05548	13.6	39.1	14.7	14.5	39.6	34.5	**52.2**	39.6	37.3	**31.68**	**51**
GOODSTREAK	23.6	57.9	33.4	23.2	45.1	35.1	**50.7**	40.0	34.8	**38.20**	**28**
SCOUT66	24.3	25.7	32.4	19.8	35.8	31.4	**46.1**	39.6	19.2	**30.48**	**54**
CHEYENNE	16.8	20.2	25.0	15.1	35.9	42.8	**44.6**	38.9	30.9	**30.02**	**55**
NE13405	21.8	65.6	28.5	18.8	37.2	28.9	**46.7**	25.9	19.3	**32.52**	**49**
NE13425	36.0	44.9	37.2	37.6	47.5	38.9	**45.8**	44.9	32.7	**40.61**	**12**
NE13434	30.4	60.2	33.9	38.0	51.6	33.3	**54.0**	47.3	42.0	**43.41**	**4**
NE13445	27.1	52.7	30.8	31.8	40.3	31.5	**55.0**	35.3	40.9	**38.38**	**26**
NW13455	18.9	51.3	29.8	16.2	35.2	40.5	**52.2**	32.3	29.8	**34.02**	**41**
NE13483V	20.2	52.5	29.0	23.5	36.5	39.3	**50.9**	39.1	33.1	**36.01**	**33**
NW13493	35.3	52.1	42.8	38.3	55.6	50.8	**53.6**	30.9	32.1	**43.50**	**3**
NW13499	9.8	40.4	22.8	18.5	34.9	33.6	**45.5**	27.9	25.1	**28.72**	**57**
NE13511	18.0	50.1	21.5	26.2	39.8	42.4	**54.6**	30.4	39.4	**35.82**	**34**
NE13515	33.6	57.7	40.4	40.6	56.8	42.4	**56.0**	52.4	47.0	**47.43**	**1**
NE13554	26.4	52.6	40.4	31.6	53.4	43.0	**50.7**	28.5	18.3	**38.32**	**27**
NW13570	39.3	50.2	40.9	29.7	45.6	44.0	**56.0**	32.5	29.5	**40.86**	**11**
NW13574	17.8	43.9	26.2	36.2	45.8	39.0	**52.6**	47.5	36.6	**38.40**	**23**
NE13593	18.7	46.0	16.6	16.9	43.7	29.8	**58.7**	41.7	36.5	**34.29**	**40**
NE13597	17.9	53.9	26.5	32.5	50.8	43.2	**49.0**	51.9	35.9	**40.18**	**17**
NE13604	23.1	54.1	31.9	28.3	51.0	43.6	**59.1**	37.9	36.0	**40.56**	**13**
NE13625	27.3	63.0	29.5	26.4	52.3	36.6	**57.7**	43.5	37.9	**41.58**	**8**
NE13629	10.6	45.4	17.2	16.8	41.4	44.9	**47.5**	35.2	36.3	**32.81**	**47**
NE13660	16.8	55.6	24.7	20.5	34.4	35.5	**45.1**	33.8	30.3	**32.97**	**45**
NW13669	25.4	39.1	32.4	37.4	54.3	51.7	**58.3**	42.8	41.8	**42.58**	**5**
NE13672	8.9	62.0	17.1	17.8	41.4	35.5	**55.5**	26.6	30.9	**32.86**	**46**
NE13683	15.3	49.1	27.2	23.6	43.7	37.2	**52.0**	33.5	34.2	**35.09**	**36**
NE13687	12.8	55.6	20.0	25.6	38.0	38.3	**55.7**	44.0	46.5	**37.39**	**31**
LCH13NEDH-11-24	19.8	44.2	28.9	24.8	47.7	50.9	**59.8**	46.5	39.4	**40.22**	**15**
LCI13NEDH-14-53	16.7	51.2	25.4	31.2	45.9	36.0	**59.0**	48.2	48.3	**40.21**	**16**
PSB13NEDH-15-58W	18.3	49.3	20.2	27.7	50.2	34.4	**59.5**	50.0	37.1	**38.52**	**22**
PSB13NEDH-14-83W	27.9	60.9	33.6	41.3	50.7	41.7	**53.8**	37.8	44.4	**43.57**	**2**
NI13717	18.5	44.1	24.6	16.2	28.5	33.6	**44.9**	23.9	26.0	**28.92**	**56**
NI14721	1.6	36.2	5.1	7.8	32.6	29.4	**45.6**	17.5	19.2	**21.67**	**60**
NI14729	28.2	54.2	35.3	31.6	62.4	41.3	**51.4**	32.2	33.0	**41.07**	**10**
NI14733	7.2	33.0	12.6	11.9	29.7	29.7	**50.4**	35.2	26.5	**26.24**	**59**
NE09517-1	16.6	46.7	23.9	34.6	53.2	28.9	**47.8**	37.5	24.8	**34.89**	**37**
NE10478-1	29.1	55.9	37.7	32.2	49.4	32.8	**55.7**	45.2	36.8	**41.64**	**7**
CV	14.42	13.62	13.54	11.67	13.36	6.97	**5.09**	16.18	10.81		
GRAND MEAN	**21.86**	**51.54**	**28.93**	**25.79**	**43.02**	**36.35**	**51.34**	**36.45**	**32.34**	**36.41**	
Heritability	0.85	0.56	0.81	0.87	0.59	0.83	**0.75**	0.57	0.79		
LSD	6.10	14.23	7.95	5.83	11.50	5.13	**5.23**	11.36	8.36		
R-Square	0.94	0.90	0.95	0.94	0.79	0.96	**0.88**	0.74	0.90		

Data for 2015 Western Triticale Forage Trial:

Line	Height	Mositure	Dry Matter	Dry Forage	RANK
		at harvest	at harvest	Yield	
	in	%	%	Lbs/acre	
NT01451	46.30	0.58	0.43	7452	2
NT05421	51.00	0.61	0.39	4310	9
NT06422	47.00	0.61	0.39	6794	4
OVERLAND	38.30	0.57	0.43	5811	5
NT07403	41.80	0.64	0.36	5344	6
NT09423	47.30	0.63	0.37	5251	7
NT11406	45.50	0.62	0.38	3356	10
NT11428	53.80	0.63	0.37	5235	8
NE422T	68.00	0.65	0.35	7605	1
NT06427	46.00	0.55	0.45	7290	3
CV	4.01	8.85	13.44	29.17	
GRAND MEAN	48.48	0.61	0.39	5845	
Heritability	0.94	0.11	0.12	0.31	
LSD	2.82	0.078	0.076	2473	

Understanding the Wheat-mite-virus Complex in Wheat

Anthony J. McMechan, Everlyne Wosula, and Gary L. Hein
Department of Entomology, University of Nebraska, Lincoln, NE 68583. Rob Higgins, High Plains Ag Laboratory, Sidney, NE

Window of risk for pre-harvest volunteer during the heading stages of wheat.

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 complex are often linked to volunteer wheat emerging before harvest. A study was conducted to determine the germination of wheat at different stages of head development and the ability of wheat curl mites to colonize this volunteer wheat. Wheat heads were collected from four varieties (Camelot, Mace, Millennium, and Pronghorn) at two separate locations during the 2011-12, 2012-13 and 2013-14 growing seasons. Heads were collected every five to seven days during head development. Each wheat head was staged, and placed on sterilized greenhouse soil in separate containers. After 21 days, wheat heads were evaluated for germination, plant height and mite presence.

Results indicate wheat can germinate as early as the early milk stage, and germination potential increases after this stage; however, the speed of germination likely will regulate the risk level for the development of volunteer wheat. Mites were able to directly colonize the germinating plants during the later heading stages (i.e. after early dough stage).

A follow up study was conducted in the field using a hail machine on Pronghorn wheat at middle milk, early, soft and hard dough stages. Results indicate that the germination of volunteer wheat was significantly impacted by wheat stage and environmental conditions.

Field studies were also conducted using a hail machine on two varieties (Camelot and Pronghorn) at late milk, early dough and soft dough stages. Results indicate significant differences in shattered grain and total germination between varieties and across hail dates. <u>It is clear from these results that the level of risk for pre-harvest hail resulting in significant volunteer and subsequent risk of wheat viruses will vary with the timing of the hail in relation to the wheat stage and with the wheat variety.</u>

Reproductive Capability of the Wheat Curl Mite (*Aceria tosichella* Keifer) on Alternative Hosts.

Wheat is an important food crop worldwide, and it is the primary crop in 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 viruses*. All of these viruses are transmitted by the wheat curl mite (WCM). Widespread outbreaks of this complex are often linked to pre-harvest volunteer wheat; however, other grass species have been implicated as important over-summering hosts. Previous research indicates that there are over 90 reported hosts for wheat curl mites. Detailed research about these alternative hosts and their role in the wheat-mite-virus complex is limited. The objective of this study was to determine the reproductive capability of wheat curl mite on some of these alternative hosts and the reproductive rate of mites when returning to wheat from these hosts. Winter wheat, jointed goatgrass, barnyardgrass, green foxtail and foxtail millet were infested with 10 mites from two distinct mite genotypes (Type 1 and Type 2) with population counts taken every seven days up to 42 days. Each treatment was replicated 16 times. Results indicate significant and consistent reproduction of mites on the primary host wheat, followed by jointed goatgrass, and barnyardgrass. Mite reproduction was erratic on green foxtail and very poor on foxtail millet. This study provides the first documentation of consistent mite reproduction on barnyardgrass, which could serve as an important over-summering host for the wheat curl mite.

Risk of alternate oversummering hosts for the wheat-mite-virus complex in winter wheat.

Wheat is the mainstay of dryland cropping systems in the western Great Plains. The wheat-mitevirus complex is the second largest cause of disease loss in winter wheat production in this region. This complex consists of three viruses transmitted by the wheat curl mite (WCM), *Wheat streak mosaic*, Wheat mosaic, and *Triticum mosaic viruses*. Widespread outbreaks of this complex are often linked to pre-harvest volunteer wheat; however, other grass species have been implicated as important oversummering hosts. A study was conducted to determine the potential for WCMs to survive on alternative hosts during the summer and serve as potential sources for mites and virus moving into fall-planted winter wheat. The primary host (wheat) and secondary hosts (corn, foxtail millet, barnyardgrass, and green foxtail) were seeded in small plots that emerged prior to winter wheat maturing. To monitor mite movement in each plot, sentinel wheat plants were grown under mite-free greenhouse conditions and exposed in the field for one-week intervals through the summer. Winter wheat was seeded around the plots in the fall to determine virus spread.

Mite activity across the plot area peaked as winter wheat matured, resulting in infestations in the treatment plots. Preharvest wheat plots were completely infested one week after harvest. The greatest mite activity and virus spread from the alternate hosts occurred with barnyardgrass, followed by foxtail millet, with lesser activity occurring in corn and green foxtail. <u>These results</u> <u>demonstrate increased risk from these alternate hosts if they are adjacent to fall planted winter</u> <u>wheat.</u>

Effect of wheat curl mite infestation and *Wheat streak mosaic virus* inoculation timing on disease severity in winter wheat.

Wheat streak mosaic virus (WSMV) is an economically important virus causing annual average yield losses of approximately 2-3% in winter wheat across the Great Plains. The wheat curl mite (WCM), *Aceria tosichella*, transmits WSMV along with two other wheat viruses. Severity of diseases caused by viruses are usually influenced by the timing of infection and prevailing climatic conditions, especially temperature. The objective of this study was to determine if the timing of infection for WSMV influences disease severity in winter wheat. In a field study conducted 2013-2014, winter wheat cultivar "Overland" was either mechanically- or miteinfested/inoculated with WSMV at three separate times (early fall, late fall and early spring). Chlorophyll meter (SPAD) readings, grain yield, number of spikes/m^2 and kernels/spike were determined. In addition, flag leaf samples were tested for WSMV using ELISA.

Grain yield was significantly reduced due WSMV infection (mite infested/inoculated) compared to the non-inoculated control by 87, 31 and 33% in early fall, late fall and early spring treatments respectively. Mechanical inoculation had a significant grain yield reduction of 40% in the early fall inoculation but no differences in late fall and early spring inoculations compared to the control. Number of spikes/m^2 was significantly reduced by 50% (mite inoculation) and 35% (mechanical inoculation) in early fall inoculation, but no reductions were seen for the late fall and early spring inoculations. Number of kernels/spike significantly reduced by 61% (mite inoculation) and 12% (mechanical inoculation) in early fall inoculation, but no differences between late fall, early spring and control inoculations. SPAD readings were significantly lower by 20% (mite inoculation) and 12% (mechanical inoculation) compared to the control. Flag leaves (mite inoculation) were found to be infected with WSMV in 92, 65 and 55% of the samples for early fall, late fall and early spring respectively, while those for mechanical inoculation were 67, 5 and 28% respectively. The results indicate that

Timing of mite infestation and virus inoculation has a significant impact on WSMV disease severity and associated yield losses with dramatically greater impact from the earliest infestation/inoculation timing. The impact from disease resulting from mite infestation was much greater than from manual inoculation of virus. Growers should avoid planting winter wheat too early in the fall season to minimize yield losses attributed to early WSMV infection.

Developing the framework for a risk map for mite vectored viruses in wheat resulting from pre-harvest hail damage in Western Nebraska, U.S.A. Anthony L. Nguy-Robertson, Arthur I. Zygielbaum, Justin McMechan, Gary L. Hein, Stephen N. Wegulo, Abby R. Stilwell, Travis Smith.

There is a strong economic incentive to reduce mite-vectored virus outbreaks. Most outbreaks in the High Plains of the United States occur in the presence of volunteer wheat that emerges before harvest as a result of hail storms. This study provides a conceptual framework for developing a risk map for wheat diseases caused by mite-vectored viruses based on pre-harvest hail events. Traditional methods that use NDVI were found to be unsuitable due to low

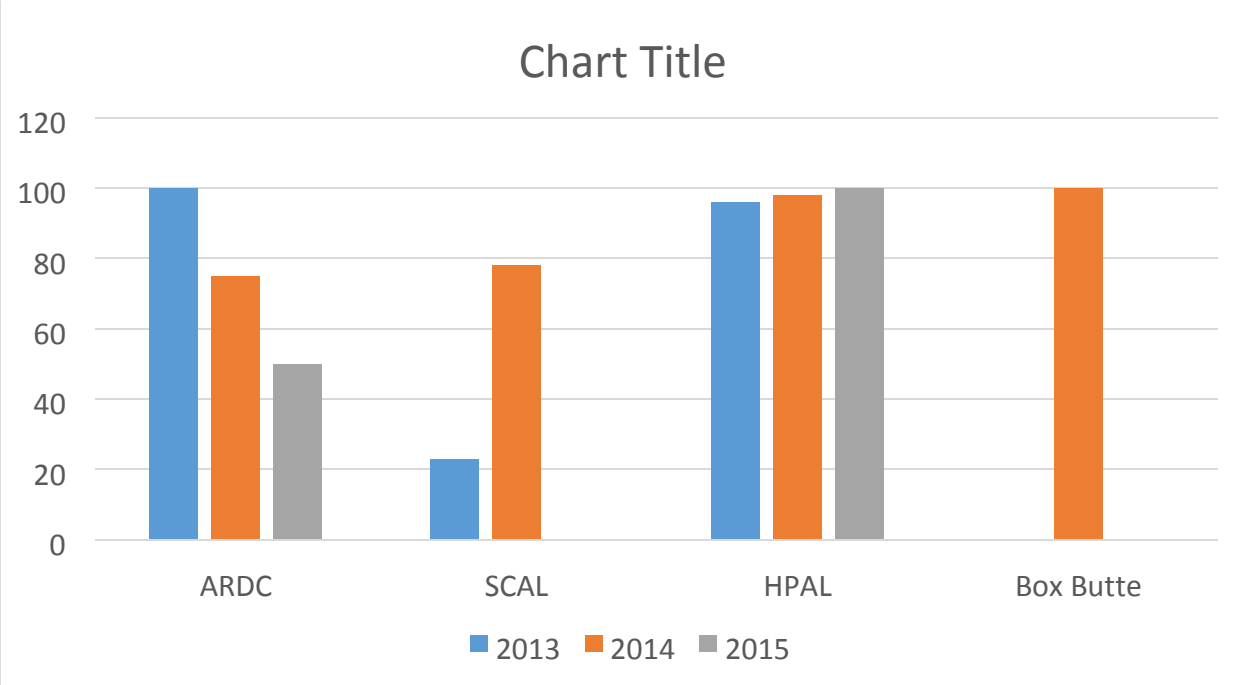
chlorophyll content in wheat at harvest. Site-level hyperspectral reflectance from mechanically hail wheat increased canopy albedo. Therefore, any increase in NIR combined with large increases in red reflectance near harvest can be used to assign some level of risk.

The regional model presented in this study utilized Landsat TM/ETM+ data and MODIS imagery was used to help gap-fill missing data. NOAA hail maps that estimate hail size was used to refine the area most likely at risk. Between 2003 and 2013, there was a moderate trend (R^2 = 0.72) between the county-level insurance claims for Cheyenne County, Nebraska and the area determined to be at risk by the model (excluding the NOAA hail size product due to limited availability) when years with low hail claims (< 400 ha) were excluded. These results demonstrate the potential of an operational risk map for mite-vectored viruses due to pre-season hail events.

Sentinel Pre-harvest Volunteer Monitoring

This study was conducted to monitor for WCM and mite vectored virus diseases at multiple locations across Nebraska. The objective of this study is to determine if the risk level for mite infestation and virus infection of pre-harvest volunteer wheat varies across the state. High levels of infestation were seen in most study areas with very consistently high levels in western Nebraska and relatively high but more variable levels in eastern Nebraska.

Figure 1. Wheat curl mite activity in pre-harvest planted sentinel wheat plots across Nebraska, 2013-2015.



High Plains Ag Lab (HPAL) Field Day

Tuesday, Aug. 11, 2015, Sidney, NE

12:00 Welcome and Lunch

12:45 Name of "The Charles R. Fenster Building"

- **Jack Whittier**, Director, Panhandle Research and Extension Center
- **Keith Rexroth**, Chair, HPAL Advisory Board
- **UNL Administrative Team**
- **Charles Fenster**, pioneering UNL researcher on dryland cropping systems In the Nebraska Panhandle and High Plains

1:30 HPAL Management and Research Update

- **Rob Higgins**, Farm Manager, HPAL (5 min)
- **How could the UNL's research and extension address the producers' need in the region?** – Karen DeBoer (5-10 min)
- **Small grains breeding at HPAL** – Stephen Baenziger (5-10 min)
- **Managing wheat curl mite and its transmitted viruses on wheat** – Gary Hein and/or Everlyne Wosula (5-10 min)

2:00 Presentations during transit to field stop-1 (repeat the same, flipping the trailers)

- **Wheat stem sawfly research update** – Jeff Bradshaw (5 min) Trailer1/Trailer 2
- **Variety testing of field pea** – Dipak Santra (5 min) Trailer 2/Trailer 1

2:30 Research Plot Tour (part 1)

- **Fenugreek, a potential medicinal crop in Nebraska** – Dipak Santra & Alex Pavlista (10 min)
- **Sorghum (Milo) in western Nebraska** – Cody Creech (10 min)
- **Tracking residual N in high rainfall year** – Gary Hergert (10 min)

3:00 Presentations during transit to field stop 2 (repeat the same, flipping the trailers)

- **Weed management for field pea production** – Cody Creech (5 min) Trailer 1/Trailer 2
- **Use of field pea in cattle feeding** – Karla Jenkins (5 min) Trailer 2/Trailer 1

3:30 Research Plot Tour (part 2)

- **Forage and range trials** – Karla Jenkins (10 min)
- **Proso millet breeding** – Dipak Santra (10 min)
- **Advanced crops research** – Bill Struckmeyer (10 min)

4:00 Adjourn with refreshment

University of Nebraska Lincoln
High Plains Ag Lab
10756 Rd 32 N
Sidney, Nebraska