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Colorado State University

Agricultural Experiment Station

College of Agricultural Sciences
Department of Soil and Crop Sciences
Plainsman Research Center
Extension

Plainsman Research Center 2009 Research Reports

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2009 Climatological Summary
Plainsman Research Center, Walsh, Colorado

Month	Temperature Max. F	Min. F	Max. Mean F	Min. Mean F	Mean F	Precip. In.	Greatest Day of Precip-atation	Snow-Fall In.	Greatest Snow Depth In.	Evapor-ation In.
Jan.	70	4	50.5	19.8	35.1	0.02	0.02	1.25	1.00	
Feb.	73	4	56.7	23.1	39.9	0.36	0.36	0.00	0.00	
Mar.	82	11	61.1	28.5	44.8	1.93	1.27	9.00	7.00	
Apr.	87	17	64.6	35.5	50.1	2.57	1.41	0.25	0.25	3.35
May	91	35	74.9	47.7	61.3	0.80	0.57	0.00	0.00	10.06
Jun.	100	42	86.5	57.2	71.9	3.71	0.98	0.00	0.00	9.34
Jul.	102	55	92	61.3	76.7	7.92	2.88	0.00	0.00	7.10
Aug.	98	52	87.7	58.2	72.9	1.75	0.94	0.00	0.00	9.65
Sept.	93	37	77.8	50.9	64.3	2.50	1.30	0.00	0.00	6.12
Oct.	93	23	58.9	35.4	47.1	6.04	3.33	0.50	0.50	0.88
Nov.	82	21	59.3	31.3	45.3	0.28	0.20	2.00	2.00	
Dec.	65	-6	40.3	14.4	27.4	0.18	0.12	1.50	1.00	
Total Annual			**67.53**	**38.61**	**53.07**	**28.06**		**14.50**		**46.50**

*** NOTE: Evaporation read mid April through October 15th.
Wind velocity is recorded at two feet above ground level.
Total evaporation from a four foot diameter pan for the period indicated.

	2009	2008
Highest Temperature:	102 degrees on Jul. 13	105 degrees on Jun. 3, Aug. 2
Lowest Temperature:	-6 degrees on Dec. 9 & 10	-5 degrees on Jan 1
Last freeze in spring:	32 degrees on Apr. 9	28 degrees on May 11
First freeze in fall:	30 degrees on Oct. 2	22 degrees on Oct. 24
2008 frost free season:	176 frost free days	166 frost free days
Avg. for 26 years:	19.95 inches	Avg for 25 years 19.65 inches

Maximum Wind:

Jan.	47 mph on 20th	July.	40 mph on 4th & 11th
Feb.	48 mph on 21th	Aug.	36 mph on 13th
Mar.	49 mph on 29th	Sept.	38 mph on 4th
Apr.	50 mph on 5th	Oct.	35 mph on 30th
May	30 mph on 26th	Nov.	46 mph on 24th
Jun.	38 mph on 7th	Dec.	42 mph on 24th & 26th

2009 Colorado Winter Wheat Variety Performance Trial Results

Jerry Johnson, CSU Crop Testing Program Leader
Scott Haley, Wheat Breeder, CSU

The following four tables were taken from the Colorado Variety Performance Database (CSU Wheat Breeding Program) at http://wheat.colostate.edu/vpt.html.

Other websites of interest are the CSU Crops Testing website for all Colorado crop performance results at http://www.csucrops.com and the Colorado Wheat Administrative Committee, CAWG, and CWRF website at http://www.coloradowheat.org.

2009 Dryland Winter Wheat Variety Performance Trial at Walsh

Variety	Yield	Test Weight	Height
	bu/ac	lb/bu	in
CO04393	35.8	59.1	25
CO04499	33.4	57.5	24
Bond CL	32.1	53.2	25
Hatcher	31.9	59.0	23
Bill Brown	31.4	59.5	22
Trego	30.7	57.1	23
CSU Blend09	30.5	58.2	22
Settler CL	30.1	56.9	23
Thunder CL	30.0	58.5	23
Overland	29.5	58.2	24
Prairie Red	29.5	56.5	23
Ankor	29.2	58.2	23
Ripper	29.2	57.3	21
Avalanche	29.2	59.6	25
TAM 111	29.2	58.2	23
Duster	29.1	55.9	24
NuDakota	28.8	54.7	23
Jagalene	28.6	59.1	24
Winterhawk	28.1	59.8	25
CO03064-2	27.9	59.1	24
Infinity CL	27.8	56.0	23
TAM 112	27.4	59.1	22
Above	27.3	56.4	22
Prowers 99	26.5	59.9	24
Goodstreak	26.4	59.1	26
Keota	25.6	58.9	25
AP00x0100-51	25.3	58.1	24
Danby	25.3	55.8	23
Jagger	24.5	58.1	24
Armour	24.5	55.6	20
CO03W054-2	24.3	57.7	23
Yuma	24.3	56.4	24
Hawken	24.2	57.1	21
Mace	22.6	54.0	23
Baca	22.0	59.0	24
Sandy	21.7	56.3	23
Fuller	19.8	55.6	22
OK Rising	19.5	56.8	21
Camelot	17.6	55.7	23
Smoky Hill	17.2	55.2	22
Trial Average	**27.0**	**57.4**	**23**
$LSD_{(0.30)}$	2.7		
Harvest date:	6/30/2009		
Planting date:	9/20/2008		
Cooperator:	Kevin Larson - Plainsman Research Center		

2009 Dryland Winter Wheat Variety Performance Trial at Lamar

Variety	Yield	Test Weight	Height
	bu/ac	lb/bu	in
CO04393	46.1	61.5	29
CO04499	45.5	61.0	27
Ankor	45.2	61.2	30
Duster	44.9	58.9	27
Bond CL	44.7	59.1	30
Ripper	44.0	60.1	26
CSU Blend09	43.8	60.1	27
Trego	42.1	59.5	28
Above	41.0	60.2	26
Avalanche	40.6	60.5	30
Bill Brown	39.8	61.6	28
CO03064-2	39.8	60.3	29
CO03W054-2	39.7	62.2	25
Thunder CL	39.6	58.6	27
Overland	39.5	60.4	29
Goodstreak	39.4	60.5	32
Hatcher	39.3	59.6	25
Baca	38.8	60.4	33
TAM 111	38.5	61.4	32
Infinity CL	38.2	59.3	27
Keota	38.0	57.1	28
Yuma	37.9	58.9	27
Smoky Hill	37.8	60.3	28
TAM 112	37.6	62.4	25
Prairie Red	37.1	60.5	24
Settler CL	36.8	57.3	24
Danby	36.5	58.5	26
Hawken	36.4	60.2	25
Camelot	35.8	60.3	29
Sandy	35.7	59.3	27
Mace	35.4	57.1	27
Armour	35.0	57.6	23
Winterhawk	34.7	60.4	25
Prowers 99	33.5	60.9	26
OK Rising	32.0	58.9	26
AP00x0100-51	32.0	58.4	24
Jagalene	31.9	60.4	24
NuDakota	31.4	58.5	23
Jagger	28.2	58.1	25
Fuller	27.3	55.9	24
Trial Average	**38.0**	**59.7**	**27**
$LSD_{(0.30)}$	2.7		
Harvest date:	7/2/2009		
Planting date:	9/10/2008		
Cooperator:	Jeremy Stulp		

2009 Dryland Winter Wheat Variety Performance Trial at Sheridian Lake

Variety	Yield	Test Weight	Height
	bu/ac	lb/bu	in
Prairie Red	46.1	60.7	28
Settler CL	44.0	62.5	27
CO04499	43.4	61.8	30
Danby	42.8	63.6	29
Ripper	42.5	61.8	28
Above	42.3	61.9	27
CO03W054-2	42.3	62.3	28
Armour	40.5	61.1	27
Sandy	40.4	62.5	28
CO04393	40.2	61.9	26
Trego	40.1	63.1	27
TAM 112	39.7	64.0	28
Infinity CL	39.6	61.7	30
Ankor	39.2	62.1	27
CSU Blend09	39.0	60.7	28
Baca	39.0	60.9	30
Duster	38.9	62.4	28
Avalanche	37.7	63.3	31
Bond CL	37.4	61.1	28
Smoky Hill	36.8	62.1	27
Overland	36.4	61.5	30
Keota	35.8	61.4	28
Hawken	35.6	61.9	25
TAM 111	35.2	62.9	28
Camelot	35.2	60.9	29
NuDakota	35.0	60.7	25
AP00x0100-51	35.0	61.8	28
CO03064-2	34.6	61.9	26
Bill Brown	34.4	62.2	25
Winterhawk	33.9	61.7	28
Jagalene	33.9	60.3	28
Mace	33.7	60.3	25
Fuller	33.5	62.1	26
Jagger	33.4	62.1	28
Goodstreak	32.8	61.8	31
Prowers 99	32.1	61.9	28
Hatcher	32.0	61.7	23
OK Rising	30.9	60.6	28
Thunder CL	30.1	60.8	24
Yuma	29.2	60.7	24
Trial Average	**37.1**	**61.8**	**27**
$LSD_{(0.30)}$	2.4		
Harvest date:	7/2/2009		
Planting date:	9/10/2008		
Cooperator:	Burl Scherler		

Dryland Wheat Strips for Forage and Grain Yield at Walsh, 2009

K. Larson, D. Thompson, D. Harn, and C. Thompson

PURPOSE: To determine which wheat varieties are best suited for dual-purpose forage and grain production in Southeastern Colorado.

MATERIALS AND METHODS: Fifteen wheat varieties were planted on September 24, 2006 at 50 lb seed/a in 20 ft. by 800 ft. strips with two replications. We applied 50 lb N/a with a sweep and seedrow applied 5 gal/a of 10-34-0 (20 lb P_2O_5, 6 lb N/a). Ally 0.1 oz/a and 2,4-D 0.38 lb/a was sprayed for weed control. Two 2 ft. by 2.5 ft. forage samples were taken at jointing (April 10) and at boot (May 4). We measure the forage for fresh weight, oven-dried the samples, and recorded dry weight at 15% moisture content. Lorsban was applied to control RWA, because RWA infestation exceeded the threshold level. No Diseases (e.g., Stripe Rust) were observed. We harvested the plots on June 30 with a self-propelled combine and weighed them in a digital weigh cart. Grain yields were adjusted to 12% seed moisture content.

RESULTS: Grain yields were low, averaging 25 bu/a, in part because of hail damage. Bond CL had the highest grain yield, 28 bu/a, but it was not significantly higher than Hatcher and Ripper. Jagalene produced the highest dry forage yield at jointing, and Keota produced the highest dry forage yield at boot. Four varieties had higher three-year grain yield averages than the trial averages. The variety with the highest three-year average yield was Bond CL.

DISCUSSION: My choice for the best overall dual-purpose wheat variety is Bond CL. Bond CL produced the highest grain yield, average forage yield at jointing, and the second highest forage yield at boot. The early forage yields indicated that Jagalene was on track for the best overall dual-purpose wheat; however, Jagalene shattered badly in the hailstorm and subsequently had the second lowest grain yield.

Grain yields of the last three years have been much above (2007), much below (2008), and near (2009) the Baca County average. Three wheat varieties, Bond CL, TAM 111, and Ankor, had above average grain yields each year of the last three seasons. Producing above average yields in response our wide ranging seasonal conditions shows that these three varieties are well adapted for our environment. Bond CL, TAM 111, and Ankor would be good varietal choices regardless of year-to-year precipitation fluctuations.

Table .Dryland Wheat Strips, Forage and Grain Yield at Walsh, 2009.

Variety	Jointing		Boot		Plant		Test	Grain
	Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.	Height	Residue	Weight	Yield
	------------------------lb/a------------------------				in	lb/a	lb/bu	bu/a
Bond CL	3173	1124	12058	3589	27	1921	61	27.6
Hatcher	3288	1198	10752	3083	24	1705	62	27.4
Ripper	2329	912	9127	2793	23	1598	63	26.7
Prairie Red	2486	910	9533	2929	24	1693	62	26.5
Ankor	3734	1387	11677	3491	24	1944	62	25.9
TAM 111	2971	1171	11020	3158	27	2243	63	25.7
Bill Brown	2666	840	10436	3053	25	1949	63	25.3
TAM 112	3829	1503	11363	3373	26	2212	63	25.0
Danby	3402	1243	11334	3298	25	1993	64	24.5
Keota	3041	1159	12119	3634	28	2070	63	24.4
Winterhawk	2722	979	10622	3027	26	1790	63	23.0
TAM 110	3278	1257	11169	3291	24	1894	62	22.9
Hawken	3315	1362	9011	2883	22	1598	62	22.4
Jagalene	3873	1530	10873	3474	26	1808	62	20.0
Santa Fe	3536	1497	9711	3042	25	1826	60	19.6
Average	3176	1205	10720	3208	25	1883	62	24.5
LSD 0.05	804.2	349.0	2911.0	816.5		548.9		0.86

Planted: September 24, 2008; 45 lb seed/a; 5 gal/a 10-34-0.
Harvested: June 30, 2009.
Jointing sample taken April 10, 2009.
Boot sample taken May 4, 2009.
Wet Weight is reported at field moisture.
Dry Weight is adjusted to 15% moisture content.

Table .--Summary: Dryland Wheat Strips Variety Performance Tests at Walsh, 2007-2009.

		Grain Yield					Yield as % of Trial Average				
					2-Year	3-Year				2-Year	3-Year
Firm	Variety	2007	2008	2009	Avg	Avg	2007	2008	2009	Avg	Avg
		bu/a					%				
Agseco	TAM 111	49	6	26	16	27	107	120	104	112	110
Agseco	TAM 110	43	3	23	13	23	93	60	92	76	82
Agseco	Keota	51	5	24	15	27	111	100	96	98	102
Agseco	Protection	49	4	--	27	--	107	80	--	93	--
AgriPro	Jagalene	46	3	20	12	23	100	60	80	70	80
Colorado State	Hatcher	51	3	27	15	27	111	60	108	84	93
Colorado State	Prairie Red	43	5	27	16	25	93	100	108	104	100
Colorado State	Above	47	4	--	26	--	102	80	--	91	--
Colorado State	Ankor	47	6	26	16	26	102	120	104	112	109
Colorado State	Bond CL	48	8	28	18	28	104	160	112	136	125
Colorado State	Ripper	42	5	27	16	25	91	100	108	104	100
Colorado State	Bill Brown	--	5	25	15	--	--	100	100	100	--
Kansas State	Danby	48	3	25	14	25	104	60	100	80	88
Watley	TAM 112	46	4	25	15	25	100	80	100	90	93
Average		46	5	25	15	25					

Grain Yields were adjusted to 12.0 % seed moisture content.

Winter Wheat Planting Date and Seeding Rate Study for Southeastern Colorado

Kevin Larson, Dennis Thompson, and Deborah Harn

Currently there is a winter wheat planting date controversy about the deadline for winter wheat planting and government program compliance. The wheat planting date compliance cutoff for Southeastern Colorado was recently extended from October 5 to October 15. This date appears to be arbitrarily selected and not based on scientific research. Our neighboring states of Kansas and Oklahoma have much later winter wheat planting date compliance deadlines. The deadline for the Panhandle of Oklahoma is November 15, a full month later than Colorado, and the deadline for Southwestern Kansas is October 20. Our winter wheat planting date and seeding rate study will ascertain the optimum planting date and seeding rate window for winter wheat production.

Materials and Methods

For our planting date and seeding rate study, we used the winter wheat variety Hatcher. We planted five planting dates: PD1, September 15; PD2, September 29; PD3, October 13; PD4, October 27; and PD5, November 10, 2008. We tested four seeding rates: 30, 60, 90, and 120 lb/a (0.422, 0.844, 1.266, and 1.688 million seeds/a). The experimental design for our study was a split-plot design (planting date as main plots, and seeding rates as subplots) with four replications. We applied N fertilizer as 32-0-0 streams at 50 lb/a to the site. For weed control, we applied Express, 0.33 oz/a and 2,4-D, 0.38 lb/a in early spring. The study was planted on beds in order to furrow irrigate the site for stand establishment. We measured Russian Wheat Aphid (RWA) infestation by sampling 25 tillers per treatment. The percentage of tillers infested with RWA was the sum of tillers with aphids and tillers damaged from RWA. Forage samples (2.0 ft by 2.5 ft) were harvested at jointing: PD1, March 25; PD2, April 2; PD3, April 10; PD4, April 20; and PD5, April 25. Forage samples were harvested at boot: PD1, May 1; PD2, May 8; PD3, May 14; PD4, May 18; and PD5, May 21. We weighed the forage samples, dried them in an oven at 100 C until no more weight loss occurred, and recorded the dry weighs. Forage yields were adjusted to 15% moisture. We harvested grain from the 10 ft. by 44 ft. plots on July 8 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 12% seed moisture content.

Results

Forage yields for all five planting dates had significant linear responses to increasing seeding rates at jointing, but not at boot. Two planting dates, September 29 and November 10, had curvilinear responses to seeding rates for boot forage yields. The earliest planting date, September 15, produced the highest forage yields at jointing and at boot. The maximum forage yield tended to decline with later planting dates at jointing: PD1, 2810 lb/a; PD2, 1190 lb/a; PD3, 528 lb/a; PD4, 610 lb/a; and PD5, 461 lb/a. The forage yield for PD4 was slightly higher than PD3 for all seeding rates at boot. PD1 at the lowest seeding rate produced more forage at jointing than PD2 at the highest seeding rate with 1299 lb/a for PD1 and 1190 lb/a for PD2. At jointing, PD1 had the highest forage yield, PD2 was intermediate, and the three later planting dates had similarly low forage yields. Surprisingly, the forage yield response at boot to increasing seeding rate for two of the five planting dates was curvilinear instead of linear. This curvilinear response is particularly confusing considering that it occurred with non-incremental planting dates, PD2 and PD5.

PD4, October 27, had the highest grain yield of 28 bu/a at the 120 lb/a seeding rate. The grain yield response to increasing seeding rate was linear for PD4 and curvilinear for the other four planting dates. The grain yield response of PD2, September 29, to increasing seeding rate was a relatively flat curve with a yield average of 25.7 bu/a. The largest grain yield response to increasing seeding rate was 14 bu/a for PD4.

Russian Wheat Aphid infestation ranged from low to high, depending on planting date, seeding rate, and sampling date. RWA infestation tended to increase with earlier planting dates, lower seeding rates, and later sampling dates. The worst RWA infestation of 50% infested tillers occurred with the earliest planting date (September 15), at the lowest seeding rate (30 lb/a), and at the last sampling date (April 2).

Discussion

The first and the last planting dates, September 15 and November 10, produced substantially lower grain yields than the middle three planting dates, September 29, October 13, and October 27. The October 27 planting date at the highest seeding rate, 120 lb/a, had the highest yield of 28 bu/a. Previous results from this study indicated that October 15 was a good planting date deadline for high wheat yields. This year, the planting date deadline could have been extended to October 27 and still achieved high yields especially when combined with high seeding rates. All five planting dates produced their highest yields at 90 to 120 lb/a seeding rates. The yield response of the planting dates to increasing seeding rates was curvilinear, except for the October 27 planting date, which was linear throughout the seeding rates. To achieve high grain yields, growers should consider seeding at higher rates.

This year's RWA results are typical of the RWA results from most of our previous wheat planting date studies with one glaring exception: the highest RWA infestation occurred with the earliest planting date, and not with the latest planting date. It is common for us to find high RWA infestation with later planting dates and lower seeding rates. Typically, it appears that less developed wheat is more susceptible to RWA or that RWA is more attracted to less developed wheat. It is difficult to explain the high RWA levels on the first planting date. This high RWA infestation level combined with high Wheat Strike Mosaic Virus infestation level were responsible for the low grain yield of the first planting.

Forage grazing can be extended from early April to late April by manipulating planting date and seeding rate, however, early planting with high seeding rate produced six times more than late planting. The forage production drop with late planting dates is too large to compensate for the three weeks extension in grazing. Forage production from each planting date at jointing increased with higher seeding rates. To produce high wheat forage yields, we recommend planting early with high seeding rates (90 to 120 lb/a).

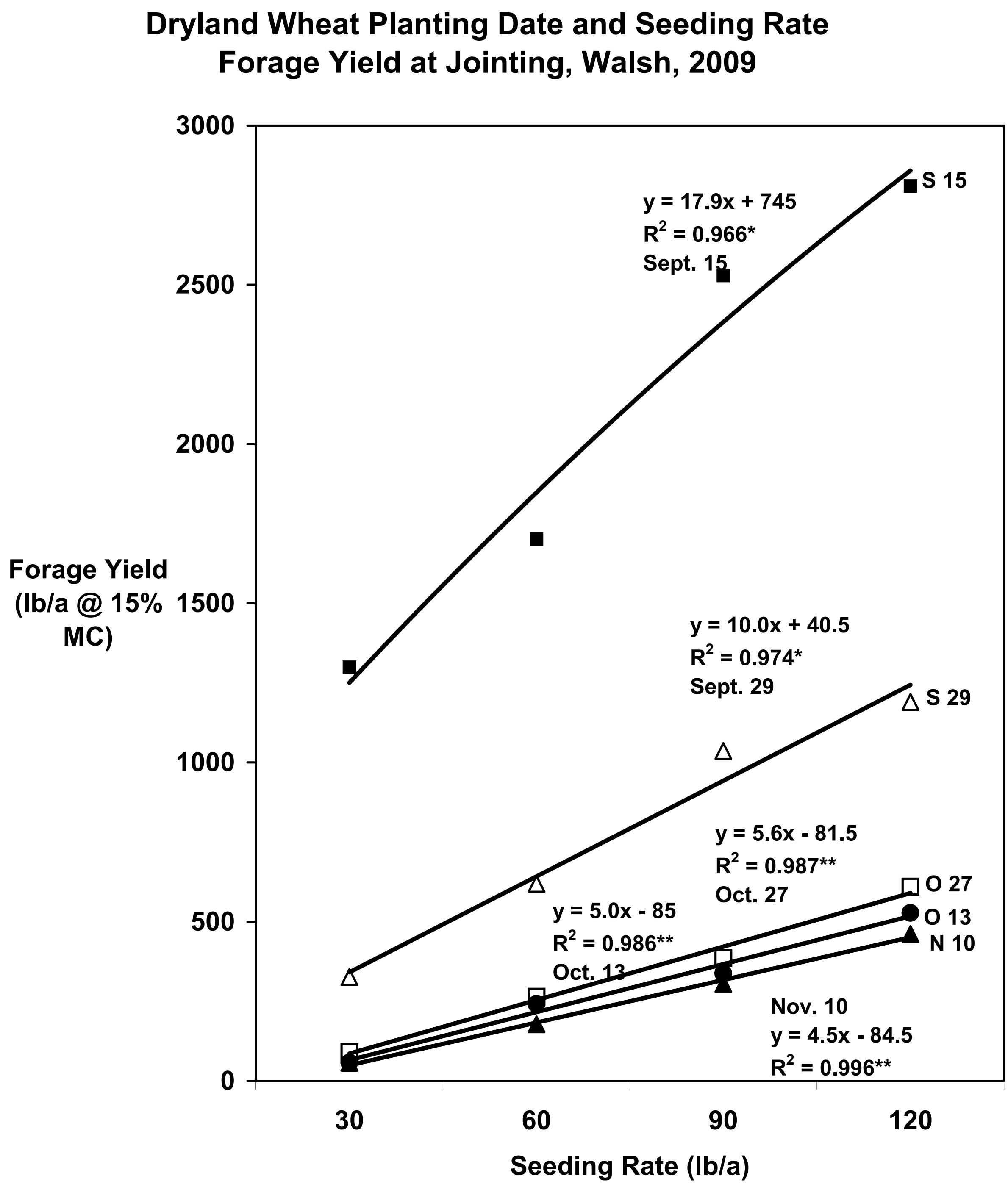

Fig. Forage yields at jointing from planting dates and seeding rates for dryland wheat at Walsh. Planting dates were PD 1, September 15; PD 2, September 29; PD 3, October 13; PD 4, October 27; and PD 5, November 10, 2008. Seeding rates were 30, 60, 90, and 120 lb/a, corresponding to 422,000, 844,000, 1,266,000, and 1,688,000 seeds/a. Jointing dates: PD 1, March 25; PD 2, April 2; PD 3, April 10; PD 4, April 20; and PD 5, April 25. The wheat variety was Hatcher.

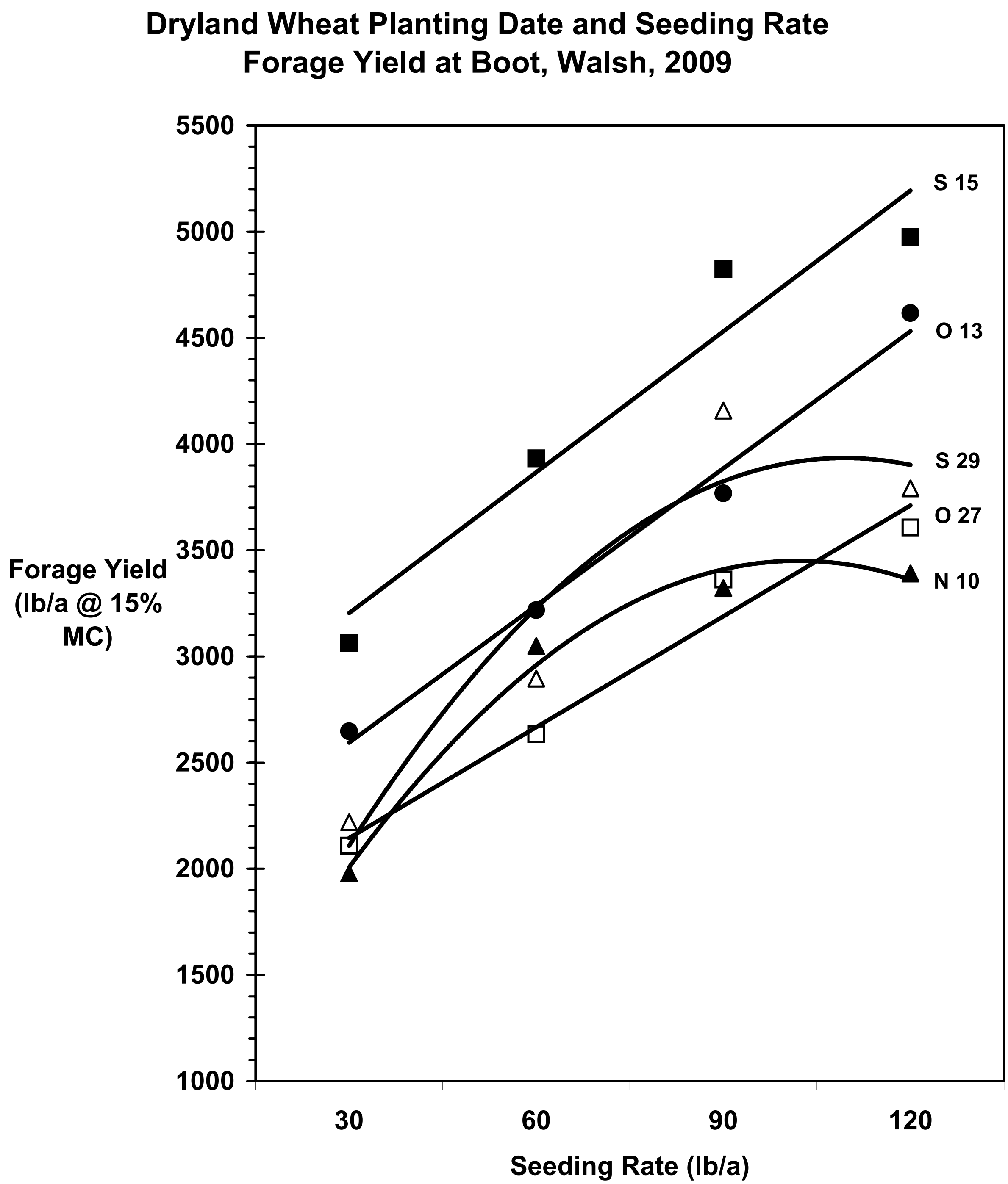

Fig. Forage yields at boot from planting dates and seeding rates for dryland wheat at Walsh. Planting dates were PD 1, September 15; PD 2, September 29; PD 3, October 13; PD 4, October 27; and PD 5, November 10, 2008. Seeding rates were 30, 60, 90, and 120 lb/a, corresponding to 422,000, 844,000, 1,266,000, and 1,688,000 seeds/a. Boot dates: PD 1, May 1; PD 2, May 8; PD 3, May 14; PD 4, May 18; and PD 5, May 21. The wheat variety was Hatcher.

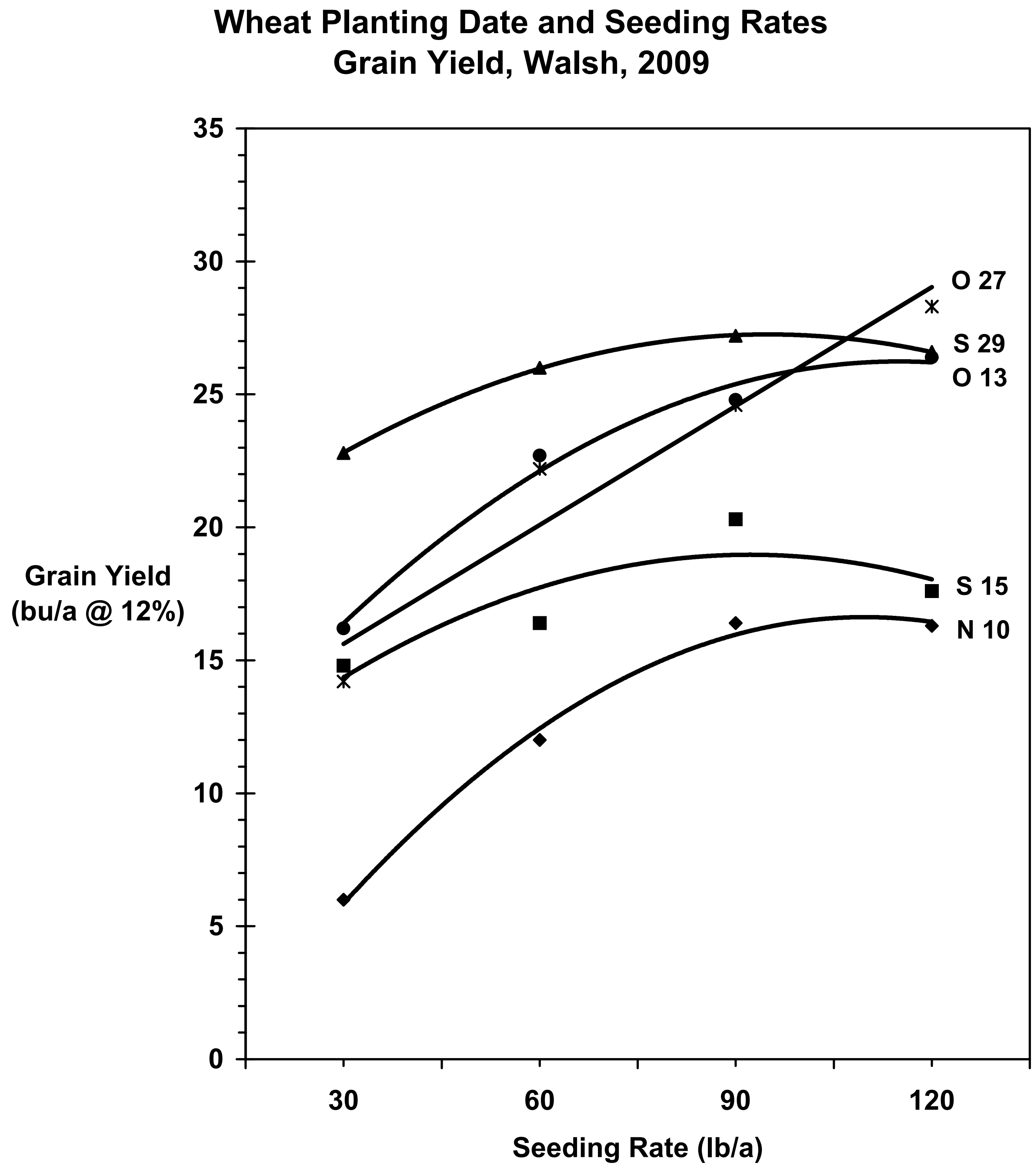

Fig. Grain yield from planting dates and seeding rates for dryland wheat at Walsh. Planting dates were PD 1, September 15; PD 2, September 29; PD 3, October 13; PD 4, October 27; and PD 5, November 10, 2008. Seeding rates were 30, 60, 90, and 120 lb/a, corresponding to 422,000, 844,000, 1,266,000, and 1,688,000 seeds/a. The wheat variety was Hatcher, which was harvested on July 8, 2009.

Table .Dryland Wheat Planting Date and Seeding Rate, Russian Wheat Aphid Infestations, Walsh, 2009.

	Planting Date					Seeding Rate			
Sample Date	PD 1 Sept. 15	PD 2 Sept. 29	PD 3 Oct. 13	PD 4 Oct. 27	PD 5 Nov. 10	SR 30 30 lb/a	SR 60 60 lb/a	SR 90 90 lb/a	SR 120 120 lb/a
	----------------------------------% Tillers Infested with RWA-------------------------------------								
February 4	6	1	1	0	0	2	2	1	2
April 2	50	8	15	12	6	50	8	15	6
RWA Average	28	5	8	6	3	26	5	8	4

RWA infestation recorded from 25 tillers sampled per treatment.

RUSSIAN WHEAT APHID AND BROWN WHEAT MITE EVALUATIONS IN A DRYLAND WINTER WHEAT PLANTING DATE X SEEDING RATE STUDY IN SOUTHEAST COLORADO. 2009. Plainsman Research Center, Walsh.

Thia Walker[1] and Deborah Harn[2], and Kevin Larson[2]
[1] Department of Bioagricultural Sciences and Pest Management, Colorado State University
[2]Department of Soil and Crop Sciences, Colorado State University

For this study, the winter wheat variety 'Hatcher' planted on five planting dates and four seeding rates. The five planting dates used were: PD1 15 Sep; PD2 29 Sep; PD3 13 Oct; PD4 27 Oct; PD5 10 Nov and four seeding rates: 30, 60, 90, and 120 lbs/A. The experimental design is a split-plot with planting date as the main plot and seed rate as the subplot using four replications. The previous crop was grain sorghum. On 2 April 2009, twenty-five tillers were collected at random from one replicate of the PD x SR study. The results of this sampling are presented in Table 1. Seeding rate does not appear to have an effect on infestation levels. However, infestation levels do appear to be affected by planting dates with the highest infestation in the earliest planted wheat. This is a phenomenon that we have observed many years when winters are mild and the aphids overwinter successfully.

Table 1. Percent Symptomatic and Infested Tillers, Total Number of RWA and Greenbug From One Replicate of Planting Date x Seeding Rate Study at Walsh, CO. 2 April 2009

Planting Date	Seed Rate	% Symptomatic	% Infested	% Infested & Symptomatic	Total % Infested	Total # RWA	Total # Greenbug
	30	4	4.2	9.6	13.8	10.2	0.2
	60	0.8	7.2	14.4	21.6	26	0.2
	90	4	2.4	7.2	9.6	7	0.6
	120	3.2	2	15	17.0	21.3	0.3
15-Sep-08		5	7.3	40	47.3	61.8	0.3
29-Sep-08		2	4	3	7.0	3.5	0.3
13-Oct-08		4	4	9.3	13.3	7.3	0
27-Oct-08		4	2	3	5.0	3	0.8
10-Nov-08		0	3	1	4.0	1.5	0.3

On 24 April 2009 numbers of brown wheat mite (*Petrobia latens*) were determined using a Vortis insect suction sampler which collects insects in an attached jar while suctioning an area $0.2m^2$. The Vortis sampler was placed over 5 randomly selected sites within each plot and allowed to suction for a 2-second period over each sample site for a composite sample per plot. The composite sample from each plot was placed on a paper plate in a Berlese funnel for 72 hours to extract mites into alcohol for counting. The results are shown in Table 2.

Table 2. Number of Brown Wheat Mites and RWA From One Replicate of Planting Date x Seeding Rate Study at Walsh, CO. 24 April 2009.

Planting Date	Seed Rate	Other BWM	Hatch BWM	total BWM	RWA	RWA Alate	LBB larva
	30	52	8.4	60.4	0.8	0	0.6
	60	73.3	11.7	85	7.8	0.2	0.3
	90	38	5.6	43.6	1.2	0	0.2
	120	54	5.2	59.2	4.6	0	0.8
15-Sep-08		191.4	22	213.4	17.6	0.2	1.6
29-Sep-08		62.2	10.4	72.6	2	0	0
13-Oct-08		13.8	0.8	14.6	0.8	0	0
27-Oct-08		10.6	2.2	12.8	1	0.2	0.4
10-Nov-08		12.6	7.2	19.8	0.8	0	0.2

It appears that seeding rate does not have an impact on BWM or RWA numbers, however, planting date appears to affect it. There were more BWM in the earliest two planting dates compared to the later planting dates. There were also more RWA in the earliest planting date, following the trend observed from the first sampling. These results are very interesting but as only sample one rep of the study was sampled, these results could not statistically analyzed.

On 27 April 2009, samples were collected for ELISA screening for wheat viruses. Samples collected from PD1 through PD 4 tested positive for Wheat Streak Mosaic Virus (WSMV) while PD 5 tested negative for WSMV. Samples from all planting dates tested negative for Cereal Yellow Dwarf Virus (CYDV- new name for Barley Yellow Dwarf Virus-rpv), Barley Yellow Dwarf-pav (BYDV), Barley Yellow Streak Mosaic Virus (BaYSMV), High Plains Virus (HPV), and Tricum Mosaic Virus (TriMV). I am particularly interested in BaYSMV as it is transmitted by the Brown wheat mite (*Petrobia latens*) and although it has been documented in several western states, it has not been documented in Colorado (to my knowledge).

Planting date appears to have a greater role in managing insect pests and plant diseases compared to seeding rate. It would be an interesting to pursue this study but, unfortunately, this was the final year of a multi-year, multi-state project and it will not be planted again. Should we find another study involving planting dates, I would like to study the BWM again.

Residual P on Dryland Wheat, Long Term Study at Manter, 2009

Kevin Larson and Lyndell Herron

PURPOSE: To determine the long-term effects from a one-time application of P rates on dryland wheat yields and incomes.

RESULTS: The highest producing P treatment was 46 lb P_2O_5/a, yielding 30 bu/a. The response to increasing P rate was slightly curvilinear with 46 P_2O_5/a as the optimum. With the price of wheat at \$4.75/bu and 10-34-0 expense already paid, the 46 lb P_2O_5/a treatment made an additional \$19.48/a this year. After four wheat crops, all P treatments are producing positive variable net incomes compared to the no P fertilizer check with the exception of the 23 lb P_2O_5/a treatment, which has remained flat.

DISCUSSION: This is the fourth wheat crop after we applied the one-time P fertilizer rates. This wheat crop is the fifth crop after P fertilization. There was an intervening grain sorghum crop before the first wheat crop, but no yields were measured. This year, all P fertilizer treatments produced higher yields than the no P check. For the first wheat crop following the P rates, the yield response from the 46 lb P_2O_5/a rate more than paid for itself (\$17.24/a return from \$31.50/a yield increase minus \$14.26/a P cost). After two wheat crops, all of the P fertilizer treatments had paid or more than paid for the P fertilizer expense. The additional yield advantage obtained from the third wheat crop for the 46 and 92 lb P_2O_5/a fertilizer treatments provided positive net incomes compared to the no P check. This year, the one-time 23 lb P_2O_5/a treatment and the no P check produced similar yields. This lack of P fertilizer response suggests that the low P rate has utilized all of its applied P. It was believed that the low P rate would be available for only one season and there would be no residual P effect because our high pH soils would bind it. However, it appears that the low P rate was available for two cropping seasons. If yields continue to response to residual P from these P rates, a heavy one-time application of P may be more profitable than smaller annual P applications.

We soil sampled after harvest in 2009 to determine if soil P analyses were reflective of our continuing yield response to single dose P rates. After four wheat crops, the soil analyses of all five P rates were similarly low, 1.5 to 1.8 ppm of P. High levels of residual soil P were not found, even for the 92 lb P_2O_5/a rate. The low levels of residual P do not reflect our continuing yield response to one-time P application of high P rates.

MATERIALS AND METHODS: Lyndell Herron chiseled on 60 lb N/a (as NH_3) with six phosphate fertilizer treatments: 0, 5.7, 11.4, 17.2, and 22.9 gal/a of 10-34-0 (0, 23, 46, 69, and 92 lb P_2O_5/a), using a 30 ft. dual placement N and P chisel applicator with 18 in. spaced shanks on July 31, 2000. Each treatment was replicated twice. Herron planted Danby in the 60 ft. by 600 ft. plots late-September 2008 at 35 lb seed/a. He applied 50 lb N/a last fall for the wheat crop this year. We harvested the plots on July 3, 2009 with a self-propelled combine and weighed them in a digital grain cart. Seed yields were adjusted to 12% seed moisture.

In 2001 and 2009, we randomly sampled the soil at 6 to 8 sites at 0 to 8 in. and 8 to 24 in. depths for 2001 and surface only (0 to 8 in.) for 2009 and sent them to the Colorado State University Laboratory for analysis. The soil was Silty Clay for both depths. The soil test recommendation for our 35 bu/a yield goal was 0 lb N/a and 40 lb P_2O_5/a for 2001, and averaged 11 lb N/a and 40 lb P_2O_5/a for the five P treatment plots in 2009; no other nutrients were required. The soil test analysis is as follows:

Table .-Soil Analysis for 2001.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------ppm-------------------------						
0-8”	7.8	0.8	1.3	11	2.1	390	0.6	5.1	15	2.5
8-24”				17						

Table .-Soil Analysis for 2009, 0 lb P_2O_5/a Treatment.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------ppm-------------------------						
0-8”	7.6	0.6	1.3	7	1.8	431	0.0	2.8	14.5	3.3

Table .-Soil Analysis for 2009, 23 lb P_2O_5/a Treatment.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------ppm-------------------------						
0-8”	7.7	0.7	1.9	7	1.5	480	0.8	5.3	17.1	3.1

Table .-Soil Analysis for 2009, 46 lb P_2O_5/a Treatment.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------ppm-------------------------						
0-8”	7.8	0.7	2.1	8	1.8	439	0.4	3.3	15.8	4.1

Table .-Soil Analysis for 2009, 69 lb P_2O_5/a Treatment.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------ppm------------------------						
0-8”	7.8	0.6	2.0	6	1.8	414	0.3	3.9	13.7	4.1

Table .-Soil Analysis for 2009, 92 lb P_2O_5/a Treatment.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------ppm------------------------						
0-8”	7.7	0.7	1.8	9	1.8	477	0.3	3.6	19.1	4.5

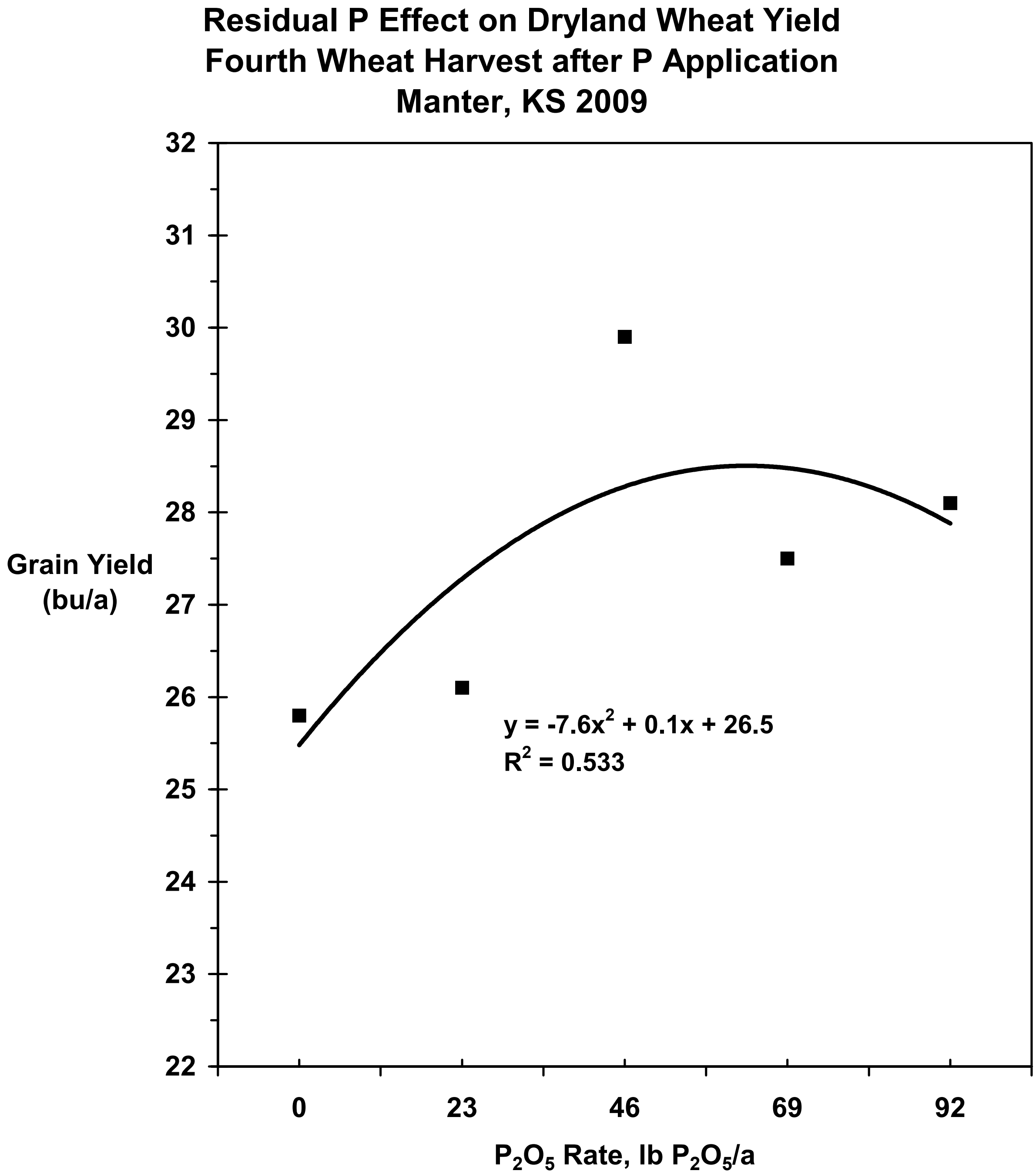

Fig. .Yield of long term P on dryland wheat, third wheat crop after P application, at Manter. P treatment are 0, 23, 46, 69, and 92 lb P_2O_5/a applied with a chisel with shanks 18 in. apart to a 6 in. depth on July 31, 2000. Grain yields were adjusted to 12% seed moisture content.

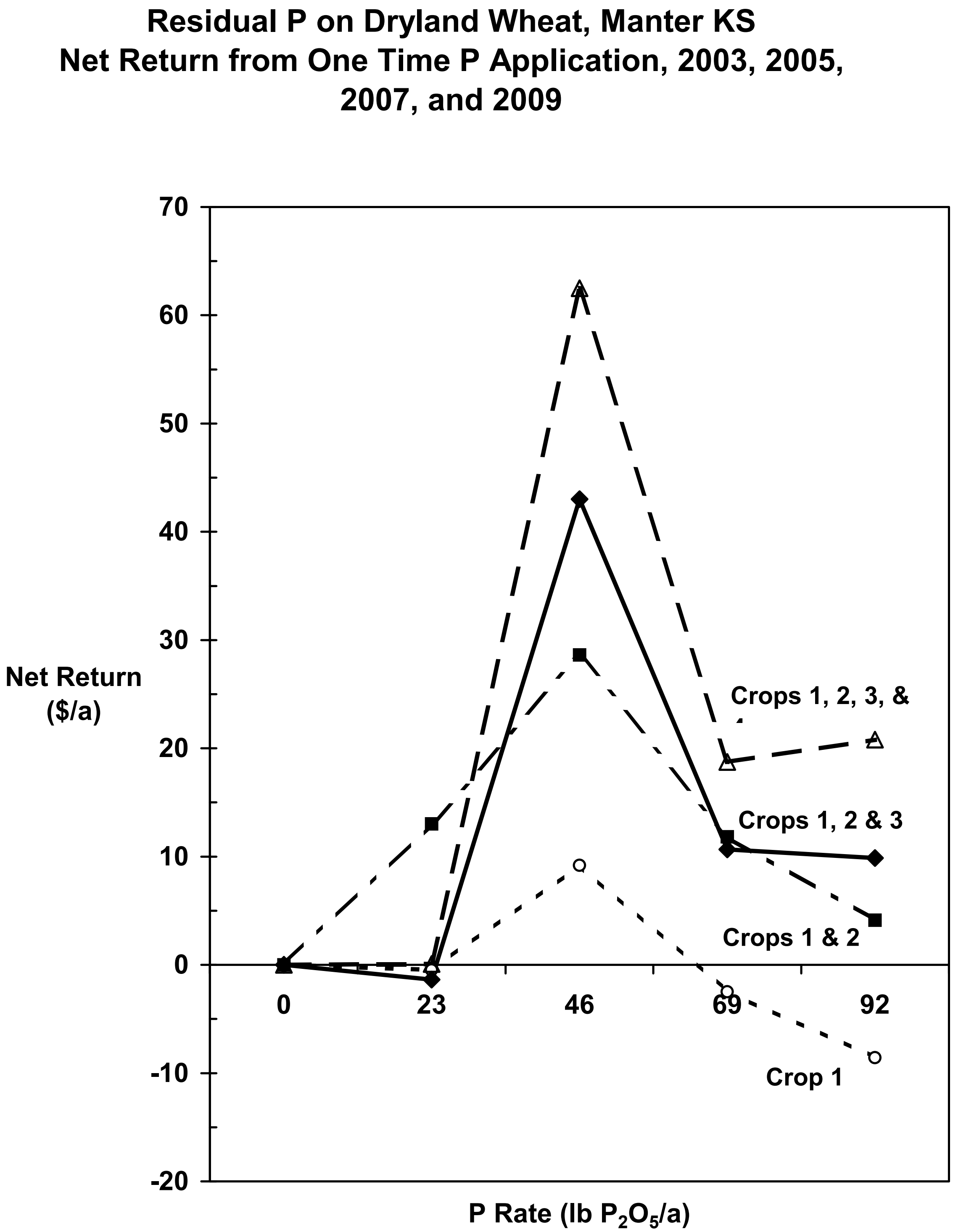

Fig. . Net return of long term P on dryland wheat, second wheat crop after P application, at Manter. P treatment are 0,23, 46, 69, and 92 lb P_2O_5/a applied with a chisel with shanks 18 in. apart to a 6 in. depth on July 31, 2000. Total net return: Crop1, year 2003, Crop 2, year 2005, Crop 3, year 2007, and Crop 4, year 2009.

Long-Term, Low-Rate, Seedrow P on Dryland Grain Sorghum

Kevin Larson, Dennis Thompson and Calvin Thompson

Banding P fertilizer with the seed at planting (seedrow placement) has proven to be a very effective P fertilizing method for dryland grain sorghum in the high lime, high alkaline soils of Southeastern Colorado. For these alkaline soils, the P fertilizer of choice for seedrow placement is liquid 10-34-0. The most common seedrow P rate for dryland grain sorghum is 5 gal/a of 10-34-0, which contains 20 lb P_2O_5 and 6 lb N/a. High rates of seedrow N are reported to cause N salt toxicity, which lowers germination (Mortvedt, 1976). Seedrow N rates higher than 6 lb N/a (the amount found in 5 gal 10-34-0/A) on 30 in. row spacing grain sorghum decreases stand and yield; however, a low, nontoxic level of seedrow N increases yields (Larson, Schweissing, and Thompson, 2000). This is the fifth crop year of our long-term study testing low seedrow P rates to determine if low rates applied on the same site for multiple years will maintain high grain sorghum yields.

Materials and Methods

We tested four rates of poly ammoniated phosphate (10-34-0) fertilizer banded with the grain sorghum seed (seedrow applied) on 30 in. row spacing in an alkaline Silty Loam soil. The four rates were 0, 1.25, 2.5, and 5.0 gallons of 10-34-0/a, corresponding to 0, 5, 10, and 20 lb P_2O_5/a (5 gal. of 10-34-0/a is the highest seedrow applied rate recommended for grain sorghum on 30 in. row spacing). The fertilizer was applied with a squeeze pump at 5 gal/A and all fertilizer rates were diluted with water to their appropriate levels. These seedrow P treatments were applied to the same plot site for all five years of the study. The study was design as a continuous grain sorghum rotation; however, dry weather prevented planting during 2002, 2004, 2006, and 2008. Therefore, the study resembled a sorghum-fallow rotation because of the dry years. The first year of this study we sampled the soil at six random locations at 0 to 8 in. (surface) and 8 to 24 in. (subsurface) depths. The soil was sent to Colorado State University Soil Testing Lab for analysis. The soil P level using AB-DTPA test was 0.9 ppm with 1.2% organic matter and a pH of 8.0. For the first year, the grain sorghum hybrid was CARGILL 627 planted at 40,000 seed/a on June 7, 2001. For the second year and third years, the grain sorghum hybrid was MYCOGEN 1482 planted at 40,000 seed/a on June 17, 2003 or June 15, 2005. For the four cropping year, we planted PIONEER 86G08 at 40,000 seed/a on June 8, 2007. For the fifth year, we planted PIONEER 86G32 at 40,000 seed/a on June 16, 2009. We harvested the 10 ft. by 500 ft. plots from early October to mid November with a self-propelled combine with a four-row crop header, and we weighed the grain in a digital scale cart. Grain yields were adjusted to 14% seed moisture content.

Results and Discussion

In a previous study, we found that 10-34-0 when seedrow applied at rates higher than 5 gal/a to 30 in. row grain sorghum lowered plant stands and grain yields (Larson, Schweissing, and Thompson, 2000). The first year of our long-term, low-rate seedrow P study (2001) there was no yield increase to increasing seedrow P rates. The check, without seedrow applied P fertilizer, produced the highest yield. There was even a slight trend of reduced yields with increasing seedrow P rates ($r^2 = 0.561$). The low coefficient of determination (r^2) indicates a random yield response to seedrow applied P. For the second crop year (2003), all seedrow P treatments produced higher yields than the no P check. There was a significant trend toward an optimum seedrow P rate of around 10 lb P_2O_5/a ($P > 0.10$). For the third crop year (2005), there was a linear trend of increasing yield with increasing seedrow P rates ($P > 0.10$). For the third crop year, the highest yield occurred at the highest P rate, 20 lb P_2O_5/a. For the fourth crop year (2007), the yield response was quite flat with a slight trend toward a low optimum P rate of 5 lb P_2O_5/a. The response of the fifth crop year was similar to the fourth crop year with a low optimum rate of 5 lb P_2O_5/a, but with a stronger optimal trend. Results from this study suggest that applying the same P rates to the same plots provides high grain sorghum yields for two crop years with applied P rates less than 10 lb P_2O_5/a. We found that the first crop year no seedrow P was needed, the second crop year the optimum rate was around 10 lb P_2O_5/a, the third crop year the highest seedrow rate tested, 20 lb P_2O_5/a, produced the highest grain sorghum yields, and the fourth and fifth crops produced optimums at 5 lb P_2O_5/a. For the first three crop years of this study, there was an increase in yield response to applied P rates. The low P rate optimum from the last two crop years of this study does not contribute to our understanding of the effects of long-term, low-rate P rates on grain sorghum yield. We expected high yields with high P rates, not with low P rates. One of the objectives of this study was to determine how long low rates of seedrow P could maintain high grain sorghum yields. We were able to maintain high sorghum crop yields for two crop years with seedrow P rates less than 10 lb P_2O_5/a. For the third crop year, the yields increased with P rates with the highest P rate, 20 lb P_2O_5/a, producing the highest yield. From the first three cropping years of this study successively higher P rates were needed to achieve high yields. This response to diminishing residual P was expected. With even less residual P, the response of the last two cropping years of low P optimums is difficult to reconcile.

The efficacy of low P seedrow rates obtained from the first two crop years indicates that low P rates are effective, at least in the short term. More P is removed with grain than is added from rates below 20 lb P_2O_5/a level: a 40 bu/a sorghum grain crop removes about 18 lb P_2O_5/a (extrapolated from Leonard and Martin, 1963). Since more P is removed with grain than is added using these low P rates, after three crop years it required the highest P rate tested, 20 lb P_2O_5/a, to produce the highest yield. We will continue this study to see if low P rates will maintain high yields, or if yields will increase with the highest seedrow P rate tested.

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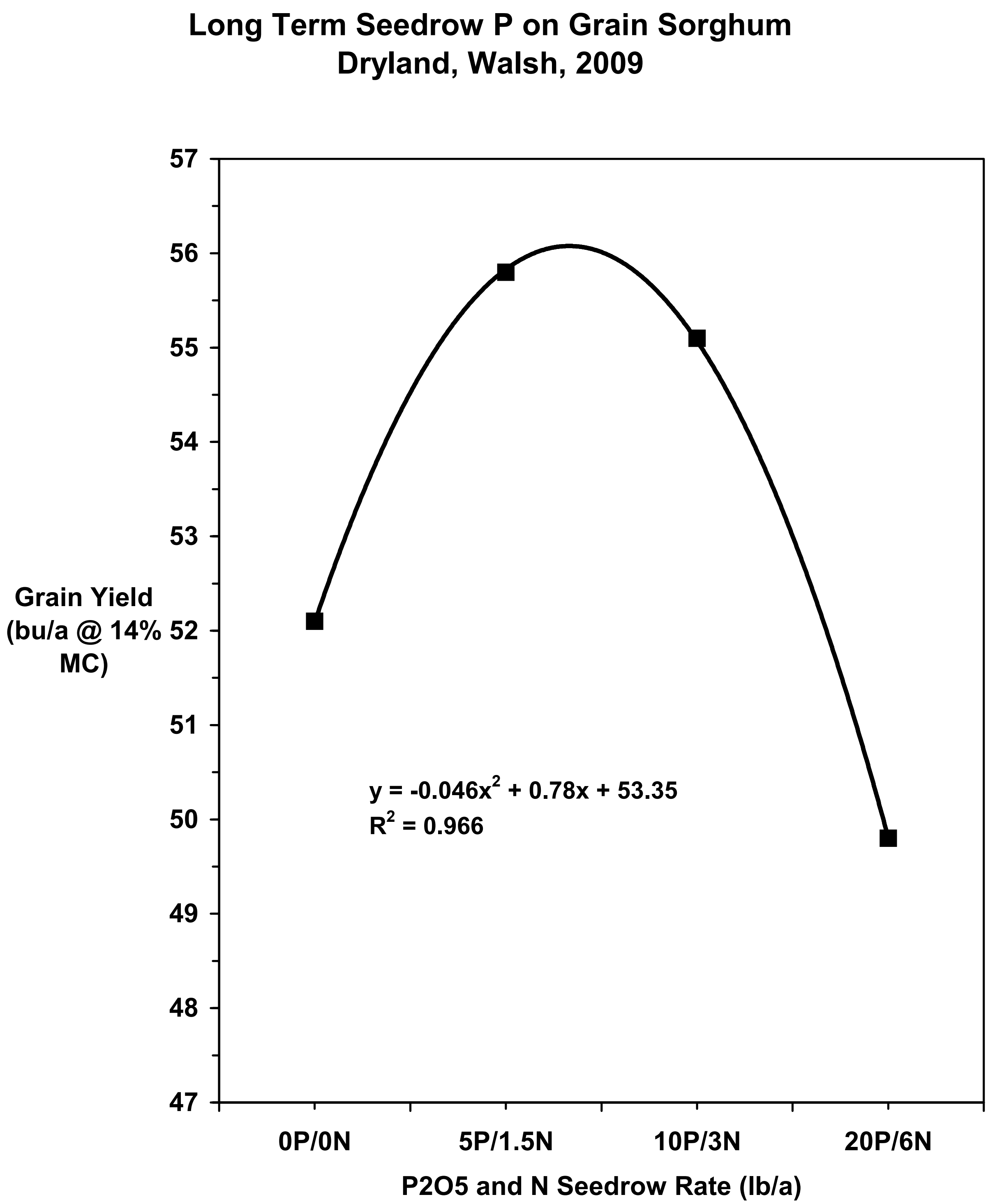

Fig. . Fifth crop of long-term seedrow P in dryland grain sorghum-fallow rotation at Walsh, 2009. Pioneer 86G32 was planted at 40,000 seeds/a. The P fertilizer was 10-34-0.

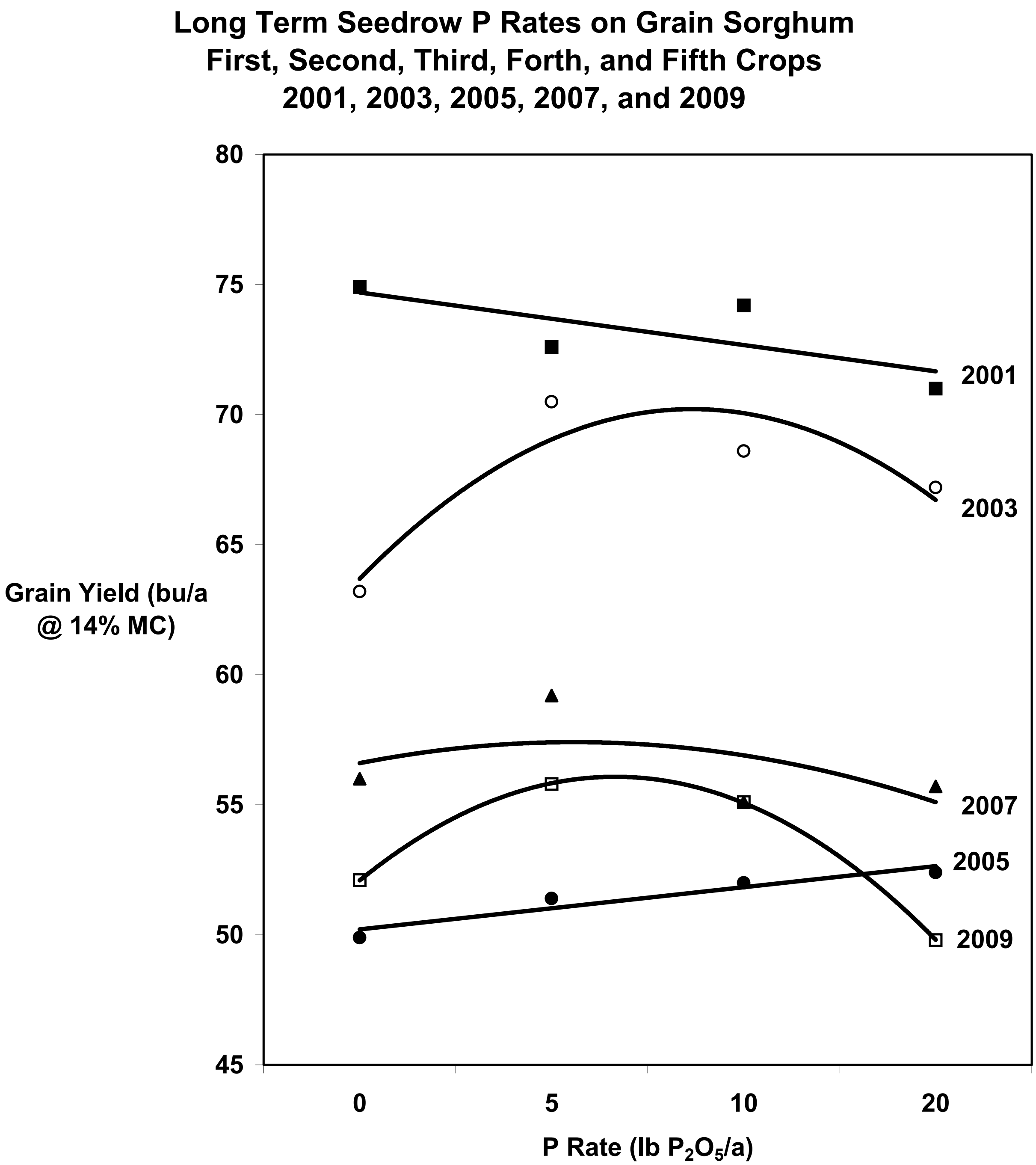

Fig. . Grain yield from three crop years of long term, low seedrow P rates on a dryland grain sorghum-fallow rotation at Walsh. The P rates were applied to the same plots all five crop years: 2001, 2003, 2005, 2007, and 2009.

Dryland Grain Sorghum Seeding Rate and Seed Maturation, Brandon, 2009

Kevin Larson and Dennis Thompson

In Eastern Colorado, dryland seeding rates vary greatly from 20,000 to 60,000 seeds/a. Lower seeding rates are typically used in the extreme southeastern part of the state where the growing season is longer, and higher seeding rates are used northward where the growing season is shorter. With lower seeding rates, abundant tillering is expected, whereas with higher seeding rates single head plants are desired. We have observed that the main head on a sorghum plant matures earlier and more uniformly than its tillers. To determine if there are yield and maturation benefits from increased seeding rates at a shorter season site, we tested a wide range of seeding rates using an early maturing, lower tillering, grain sorghum hybrid.

Materials and Methods

The six seeding rates we tested were 20, 30, 40, 50, 60, and 70 seeds/a X 1000 (16,000 seeds/lb). We planted on June 5 with a four-row cone planter on 30 in. row spacing. The grain sorghum hybrid was Mycogen 1G557. The site was fertilized with 60 lb N/a and 5 gal/a 10-24-0, 6 S, 0.1 Zn. Weed control was achieved with pre and post emergence herbicides (pre, glyphosate 32 oz/a, atrazine 0.9 lb/a; post, Ally 0.05 oz/a, 2,4-D amine 0.5 lb/a, and 2,4-D amine 0.5 lb/a applied with drops). We harvested the study on November 20 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 14% moisture content.

Results and Discussion

The highest yielding seeding rate was 60,000 seeds/a, which developed 36,600 plants/a (Fig. 1). The optimum seeding rate was 55,000 seeds/a. The high seeding rate optimum is partly attributable to earlier and more uniform seed maturation from increased numbers of single head plants. Time to maturation was shortened with increased seeding rates (Fig. 2). For each 10,000 seeds/a increment, between 20,000 and 70,000 seeds/a, maturation time was shortened by one day. A seeding rate of 70,000 seeds/a matured 5 days earlier than a seeding rate of 20,000 seeds/a. The reason this occurred was because of reduced tillering. High seeding densities produce more single head plants than lower seeding densities, and single head plants mature earlier and more uniformly than plants with multiple tillers.

Shortening maturation time by increasing seeding rates is a tool sorghum growers can utilize when planting late, or when planting in short season conditions. However, there may be a detrimental side effect from higher seeding rates, because increased seeding rates corresponded to increased lodging. Plant lodging increased linearly from 10% with 20,000 seeds/a to 45% with 70,000 seeds/a (Fig. 3). Although this lodging effect may not be as evident with all hybrids, because some hybrids are known to lodge less than other hybrids, lodging would be more likely to occur with higher seeding rates. Higher seeding rates group plant together causing them to be taller (Table 1) with smaller diameter stalks. Obviously, sorghum plants with smaller diameter stalks would have a tendency to lodge more easily.

A positive side effect of higher seeding rates was a trend toward increasing test weight (Table 1). There is a strong correlation between test weight and seed maturation

(Larson, 1993). Fully mature seeds have higher test weights than immature seeds. Since higher seeding rates had earlier seed maturation dates, heavier test weights would be expected with higher seeding rates, particularly with an abbreviated growing season.

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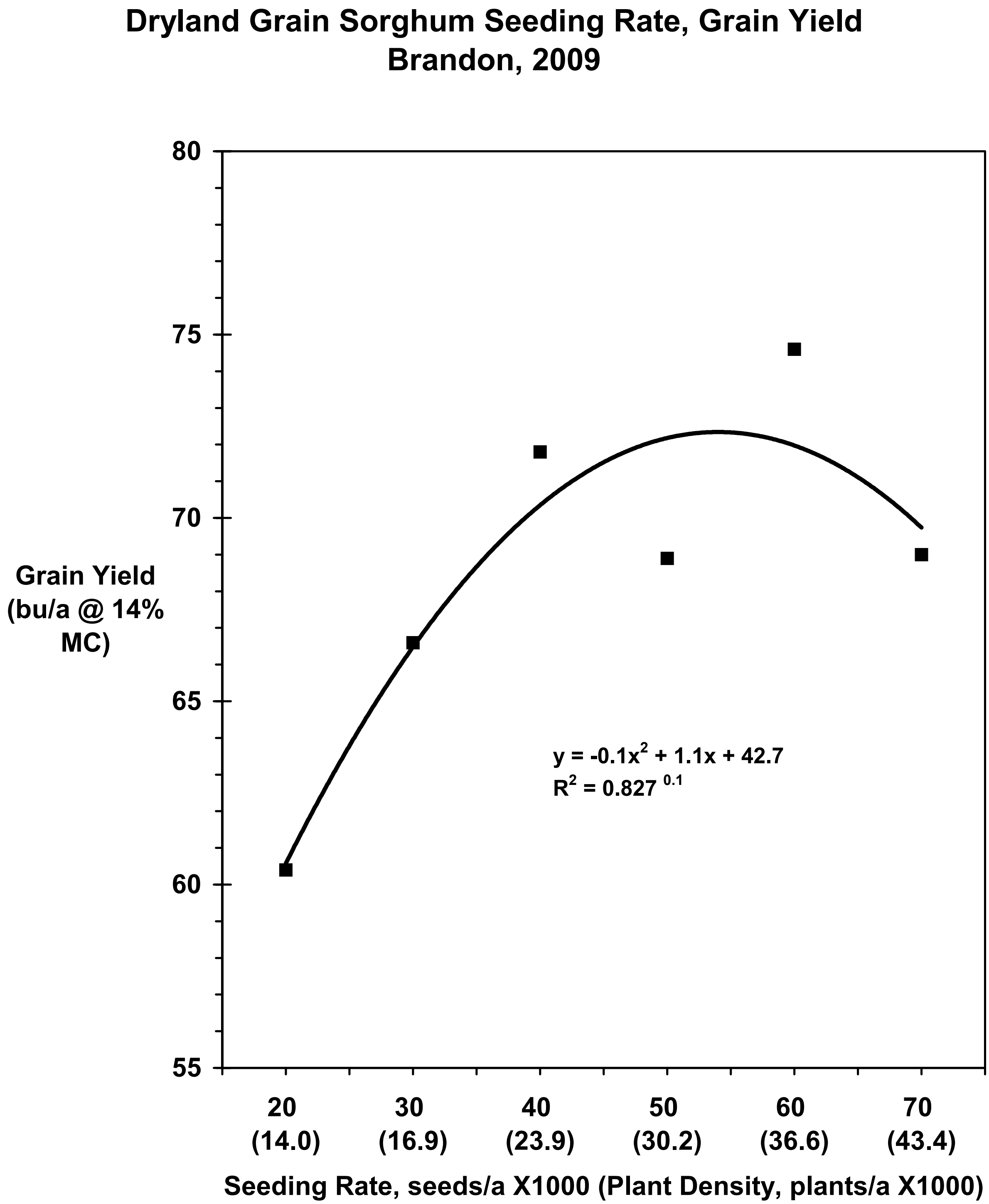

Fig. 1. Grain yield of dryland grain sorghum seeding rate study at Brandon. Seeding rates were 20, 30, 40, 50, 60, and 70 seeds/a X1000. The hybrid was Mycogen 1G557 planted on June 5, 2009.

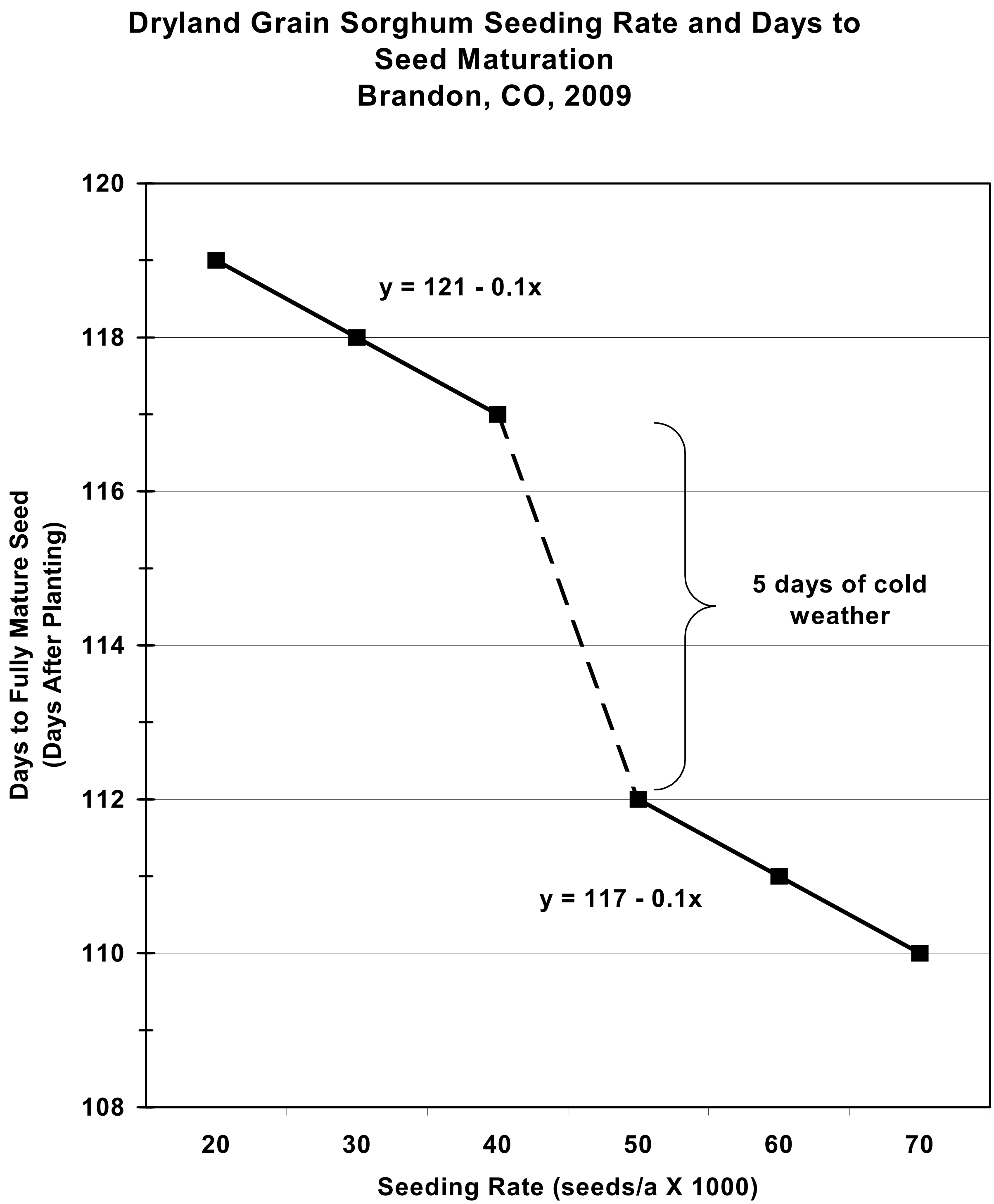

Fig. 2. Dryland grain sorghum seeding rate and days to seed maturation at Brandon. The seeding rates were 20, 30, 40, 50, 60, and 70 seeds/a (X1000). The grain sorghum hybrid was Mycogen 1G577.

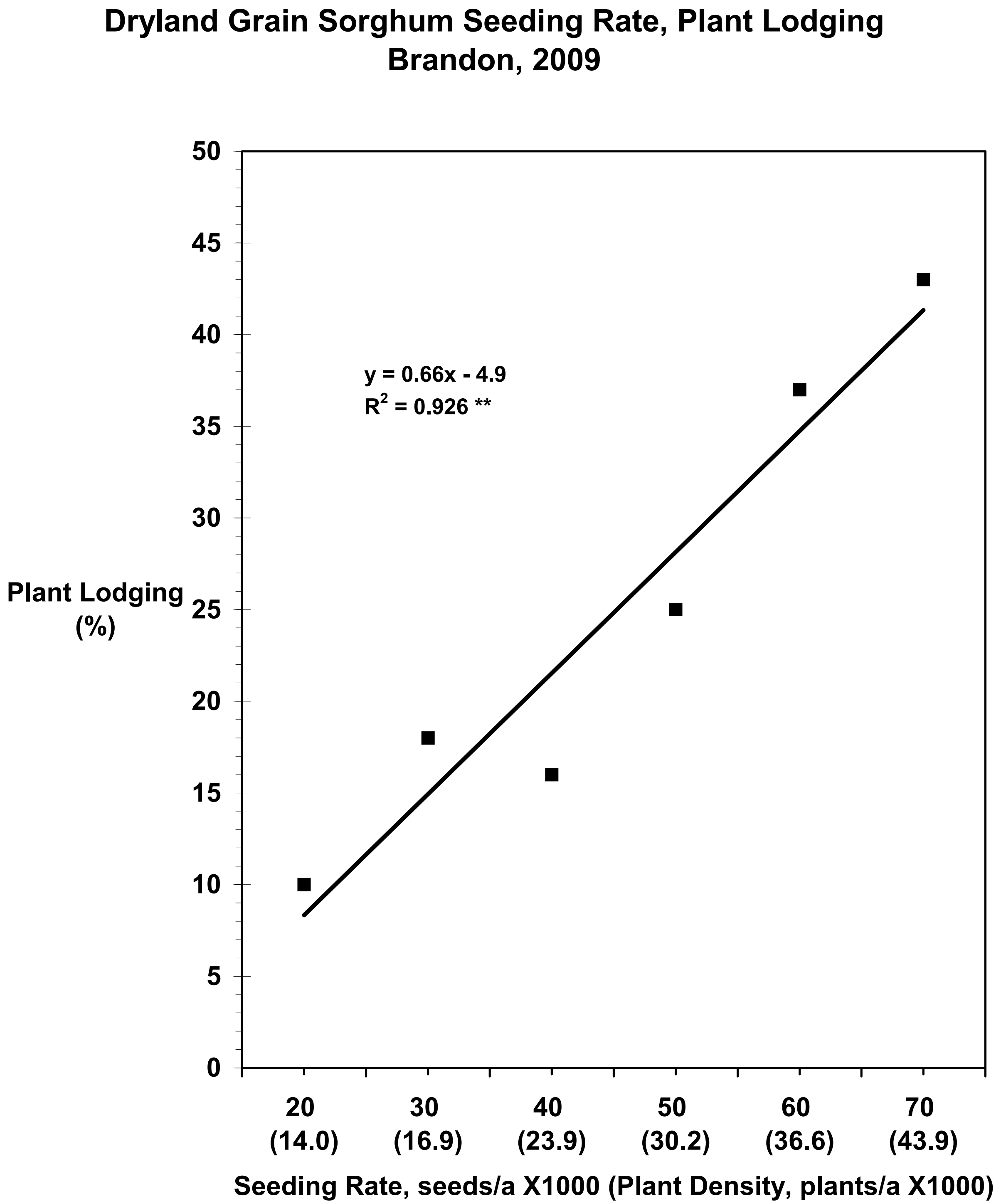

Fig. 3. Plant lodging of dryland grain sorghum seeding rate study at Brandon. The seeding rates were: 20, 30, 40, 50, 60, and 70 seeds/a X1000. The grain sorghum hybrid was Mycogen 1G557 planted on June 5, 2009.

Table 1.-Dryland Grain Sorghum Seeding Rate Study at Brandon, 2009.

Seeding Rate	Plant Density	Flowering Date	Maturation Date	Plant Height	Plant Lodging	Test Weight	Grain Yield
seeds/a (X1000)	plants/a (X1000)			In	%	lb/bu	bu/a
20	14.0	8/9	10/2	35	10	57	60
30	16.9	8/9	10/1	37	18	58	67
40	23.9	8/9	9/30	36	16	58	72
50	30.2	8/9	9/25	39	25	59	69
60	36.6	8/9	9/24	38	37	58	75
70	43.4	8/9	9/23	40	43	59	69
Average	27.5	8/9	9/28	38	25	58	69

Planted: June 5; Harvested: November 20, 2009.
Grain Sorghum Hybrid: Mycogen 1G557.
Grain yields were adjusted to 14% seed moisture content.

Dryland Grain Sorghum Hybrid Performance Trial at Brandon, 2009

COOPERATORS: Burl Scherler, Sand Creek, Inc., Brandon, Colorado, and Kevin Larson, Superintendent, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under dryland conditions with 2400 sorghum heat units in Silty Loam soil.

PLOT: Four rows with 30" row spacing, 50' long. SEEDING DENSITY: 43,600 seed/a. PLANTED: June 5. HARVESTED: November 20.

EMERGENCE DATE: 10 days after planting. SOIL TEMP: 62 F.

PEST CONTROL: Preemergence Herbicides: Glyphosate 32 oz/a, Atrazine 0.9 lb/a. Post Emergence Herbicides: Ally 0.05 oz/a, 2,4-D amine 0.5 lb/a, and 2,4-D amine (with drops). CULTIVATION: None. INSECTICIDES: None.

Summary: Growing Season Precipitation and Temperature \1
Chivington, Kiowa County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------no. of days--------		
June	2.32	523	10	0	25
July	5.14	741	18	0	56
August	2.44	672	13	2	87
September	0.71	461	4	0	117
October	0.00	7	0	0	118
Total	10.61	2404	45	2	118

\1 Growing season from June 5 (planting) to October 1 (first freeze, 25 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

FIELD HISTORY: Last Crop: Sunflower. FIELD PREPARATION: No-till.

COMMENTS: Planted in good soil moisture. Weed control was very good. Near normal precipitation for the growing season, however, July was wet and September was dry. No greenbug infestation. Five hybrids had more than 10% lodging. Yields and test weights were good despite the early freeze date.

SOIL: Silty Loam for 0-8" and Silty Loam 8"-24" depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8"	7.7	0.7	2.5	10	8.1	445	0.5	3.8
8"-24"				7				
Comment	Alka	VLo	VHi	Mod	Med	VHi	Lo	Marg

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	20	0	0
Applied	60	13	0.1	0

Yield Goal: 50 bu/a.
Actual Yield: 57 bu/a.

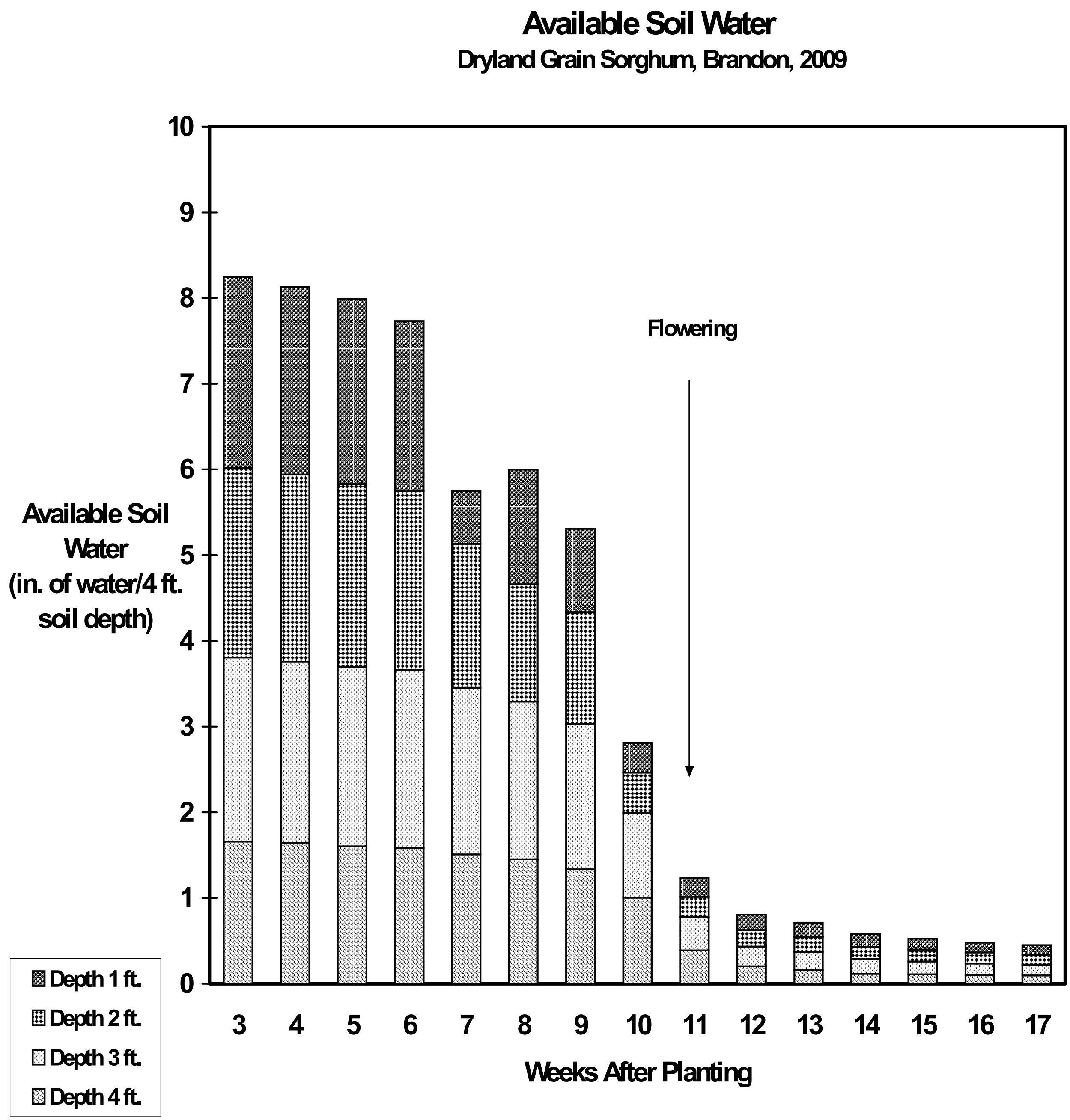

Fig. 1. Available soil water in dryland grain sorghum at Brandon. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Brandon from planting to first freeze was 10.61 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table 3.--Dryland Grain Sorghum Hybrid Performance Test at Brandon, 2009. \1

Brand	Hybrid	Days to Emerge	50% Bloom DAP	50% Bloom GDD	50% Mature DAP	50% Mature Group	Plant Ht.	Harvest Density	Plants Lodged	Test Wt.	Grain Yield	Yield % of Test Average
							in	plants/a (1000 X)	%	lb/bu	bu/a	%
MYCOGEN	1G557	10	66	1508	116	E	38	31.4	18	57	67	118
DEKALB	DKS 28-05	11	66	1508	116	E	41	31.8	39	57	65	116
DEKALB	DKS29-28	11	66	1508	118	E	37	25.6	14	58	64	114
SORGHUM PARTNERS	251	11	63	1436	112	E	38	24.4	5	58	60	106
SORGHUM PARTNERS	SP 3303	12	69	1579	118	E	41	15.1	1	56	47	84
AERC	CGSH 8	11	65	1286	116	E	43	18.2	66	56	46	81
AERC	CGSH 27	11	63	1436	115	E	38	10.8	93	56	40	70
DEKALB	DKS37-07	11	74	1686	HD	ME	42	30.2	1	56	66	117
DEKALB	DKS36-06	11	73	1670	119	ME	44	32.4	2	56	63	112
SORGHUM PARTNERS	KS310	9	74	1686	119	ME	40	29.4	6	56	62	110
ASGROW	Pulsar	9	73	1670	119	ME	42	25.2	5	56	58	102
DEKALB	DK39Y	11	72	1652	119	ME	37	22.8	1	57	56	98
SORGHUM PARTNERS	NK5418	10	80	1813	HD	ME/M	40	22.8	1	55	55	97
TRIUMPH	TR 452	10	78	1759	HD	ME	41	25.9	1	55	54	96
SORGHUM PARTNERS	K35Y5	9	73	1670	119	ME	37	25.6	4	56	53	94
MYCOGEN	M3838	10	79	1788	SD	ME	39	27.9	1	53	49	87
Average		10	67	1603	119	ME	40	25.0	16	56	57	
LSD 0.20											6.7	

\1 Planted: June 5; Harvested: November 20, 2009.
Yields are adjusted to 14.0% seed moisture content.
DAP: Days After Planting or maturation of seed at first freeze.
Seed Maturation: EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough; mature (DAP).
GDD: Growing Degree Days for sorghum.
Maturity Group: E, early; ME, medium early; M, medium; ML, medium late; L, late.

Dryland Grain Sorghum Hybrid Performance Trial at Walsh, 2009

COOPERATORS: Plainsman Agri-Search Foundation, and Kevin Larson, Superintendent, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under dryland conditions with 2550 sorghum heat units in a Silty Loam soil.

PLOT: Four rows with 30” row spacing, 50’ long. SEEDING DENSITY: 43,600 seed/a. PLANTED: June 8. HARVESTED: November 4.

EMERGENCE DATE: 8 days after planting. SOIL TEMP: 74 F.

PEST CONTROL: Preemergence Herbicides: Glyphosate, 24 oz/a; 2,4-D, 0.5 lb/a. Post Emergence Herbicides: Banvel 4.0 oz/a, Atrazine 1.0 lb/a, COC 32 oz/a. CULTIVATION: Once. INSECTICIDES: None.

FIELD HISTORY: Last Crop: Wheat. FIELD PREPARATION: No-till.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------no. of days--------		
June	2.18	521	11	1	22
July	7.92	824	19	5	53
August	1.75	712	15	0	84
September	2.50	467	5	0	114
October	0.00	28	1	0	116
Total	14.35	2552	51	6	116

\1 Growing season from June 8 (planting) to October 2 (first freeze, 30 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

COMMENTS: Planted in good soil moisture. Weed control was good. Above normal precipitation for the growing season with a very wet July. No greenbug infestation. Only minor lodging. Early freeze date. Yields and test weights were good.

SOIL: Silty Loam for 0-8” and Silty Loam 8”-24” depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.6	0.6	1.7	25	5.6	379	0.3	2.4
8”-24”				24				
Comment	Alka	Vlo	Hi	Hi	Lo	VHi	VLo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	20	2	0
Applied	50	20	0.3	0

Yield Goal: 45 bu/a.
Actual Yield: 53 bu/a.

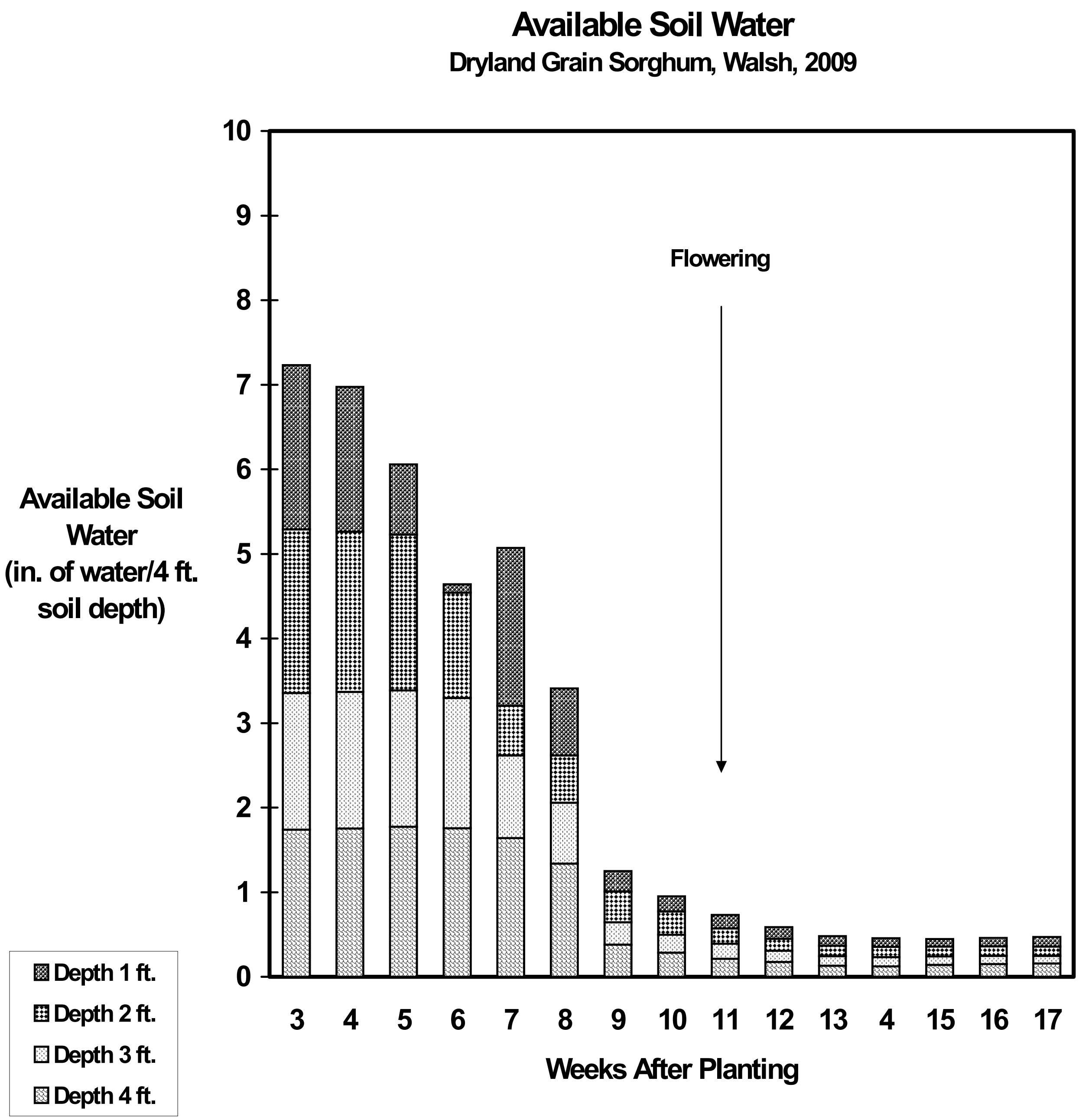

Fig. 2. Available soil water in dryland grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 14.35 in. Any increase in available soil water between weeks is from rain.

Table 4.--Dryland Grain Sorghum Hybrid Performance Test at Walsh, 2009. \1

Brand	Hybrid	Days to Emerge	50% Bloom DAP	50% Bloom GDD	50% Mature DAP	50% Mature Group	Plant Ht.	Harvest Density	Plants Lodged	Test Wt.	Grain Yield	Yield % of Test Average
							in	plants/a (1000 X)	%	lb/bu	bu/a	%
DEKALB	DKS 28-05	8	59	1501	103	E	44	26.3	0	59	61	115
DEKALB	DKS29-28	8	61	1562	104	E	37	34.1	0	60	60	113
SORGHUM PARTNERS	K35Y5	8	63	1612	104	E	35	24.4	0	59	55	103
SORGHUM PARTNERS	SP 3303	10	61	1562	104	E	39	20.1	0	59	46	86
SORGHUM PARTNERS	251	9	57	1446	99	E	34	32.5	1	59	45	83
AERC	CGSH 8	9	58	1473	101	E	42	20.5	4	56	40	75
AERC	CGSH 27	9	55	1345	99	E	42	19.4	3	56	25	47
SORGHUM PARTNERS	KS310	7	66	1683	107	ME	42	30.2	0	60	72	135
SORGHUM PARTNERS	NK5418	9	69	1760	110	ME/M	37	28.3	0	58	65	122
TRIUMPH	TR 448	8	68	1737	114	ME	42	30.6	0	60	64	119
TRIUMPH	TR 452	8	67	1712	107	ME	42	24.8	0	58	62	116
TRIUMPH	TR 438	9	65	1660	105	ME	42	24.8	0	58	62	116
ASGROW	Pulsar	9	65	1660	110	ME	41	29.4	1	59	56	104
DEKALB	DK39Y	9	65	1660	109	ME	36	28.3	0	59	51	96
DEKALB	DKS36-06	8	71	1795	117	M	46	30.4	0	56	67	125
DEKALB	DKS37-07	8	72	1810	117	M	41	28.7	0	56	65	121
TRIUMPH	X84732	8	73	1829	117	M	43	29.8	0	56	63	117
TRIUMPH	X95003	8	76	1891	HD	M	47	27.5	0	55	56	104
(Check)	399 X 2737	8	79	1972	SD	ML	40	25.2	0	53	38	72
TRIUMPH	X85002	9	88	2149	SD	ML	45	28.3	0	52	15	28
Average		8	67	1691	109	ME	41	27.2	0	57	53	
LSD 0.20											7.2	

\1 Planted: June 8; Harvested: November 4, 2009.

Yields are adjusted to 14.0% seed moisture content.

DAP: Days After Planting or maturation of seed at first freeze.

Seed Maturation: EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough; mature (DAP).

GDD: Growing Degree Days for sorghum.

Maturity Group: E, early; ME, medium early; M, medium; ML, medium late; L, late.

Table 5.--Summary: Dryland Grain Sorghum Hybrid Performance Tests at Walsh, 2007-2009.

		Grain Yield					Yield as % of Test Average				
					2-Year	3-Year				2-Year	3-Year
Brand	Hybrid	2007	2008	2009	Avg	Avg	2007	2008	2009	Avg	Avg
		------------------bu/a---------------------					----------------------%----------------------				
ASGROW	Pulsar	63	75	56	66	65	108	112	104	108	108
DEKALB	DKS37-07	62	75	65	70	67	105	112	121	117	113
DEKALB	DKS36-16	60	73	67	70	67	102	110	125	118	112
DEKALB	DKS29-28	61	65	60	63	62	104	98	130	114	111
DEKALB	DK39Y	--	63	51	57	--	--	95	96	96	--
NC+	NC+ 5B89	62	69	--	66	--	105	109	109	109	--
NC+	NC+ 5C35	55	71	--	63	--	93	107	107	107	--
NC+	NC+ Y363	60	73	--	67	--	103	110	110	110	--
NC+	NC+ 6B50	61	75	--	68	--	104	113	113	113	--
NC+	NC+ 7C22	66	71	--	69	--	112	107	107	107	--
SORGHUM PARTNERS	KS310	54	63	72	68	63	92	95	135	115	107
SORGHUM PARTNERS	251	50	49	45	47	48	86	74	83	79	81
SORGHUM PARTNERS	NK5418	72	77	65	71	71	123	116	122	119	120
(Check)	399 X 2737	42	58	38	48	46	71	87	72	80	77
Average		59	66	53	60	59					

Grain Yields were adjusted to 14.0% seed moisture content.
The site was pre-irrigated with furrow irrigation in 2008.

Dryland Forage Sorghum Hybrid Performance Trial at Walsh, 2009

COOPERATORS: Plainsman Agri-Search Foundation, and Kevin Larson, Superintendent, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under dryland conditions with 2500 sorghum heat units in a Silty Loam soil.

PLOT: Four rows with 30” row spacing, 50’ long. SEEDING DENSITY: 69,700 seed/a. PLANTED: June 9. HARVESTED: October 26.

EMERGENCE DATE: 9 days after planting. SOIL TEMP: 75 F.

PEST CONTROL: Preemergence Herbicides: Glyphsate 24 oz/a, 2,4-D 0.5 lb/a. Post Emergence Herbicides: Atrazine 1.0 lb/a, Banvel 4 oz/a, COC 32 oz/a. CULTIVATION: Once. INSECTICIDES: None.

FIELD HISTORY: Last Crop: Wheat. FIELD PREPARATION: No-till.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------no. of days--------		
June	2.18	503	11	1	21
July	7.92	824	19	5	52
August	1.75	712	15	0	83
September	2.50	467	5	0	113
October	0.00	28	1	0	115
Total	14.35	2534	51	6	115

\1 Growing season from June 9 (planting) to October 2 (first freeze, 30F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

COMMENTS: Planted in good soil moisture. Weed control was good. Above normal precipitation for the growing season with a very wet July. No greenbug infestation. Three hybrids had greater than 10% lodging. Forage yields were good.

SOIL: Silty Loam for 0-8” and Silty Loam 8”-24” depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.6	0.6	1.7	25	5.6	379	0.3	2.4
8”-24”				24				
Comment	Alka	VLo	Hi	VHi	Lo	VHi	VLo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	20	2	0
Applied	50	20	0	0

Yield Goal: 9 ton/a.
Actual Yield: 13.5 ton/a @ 70% MC.

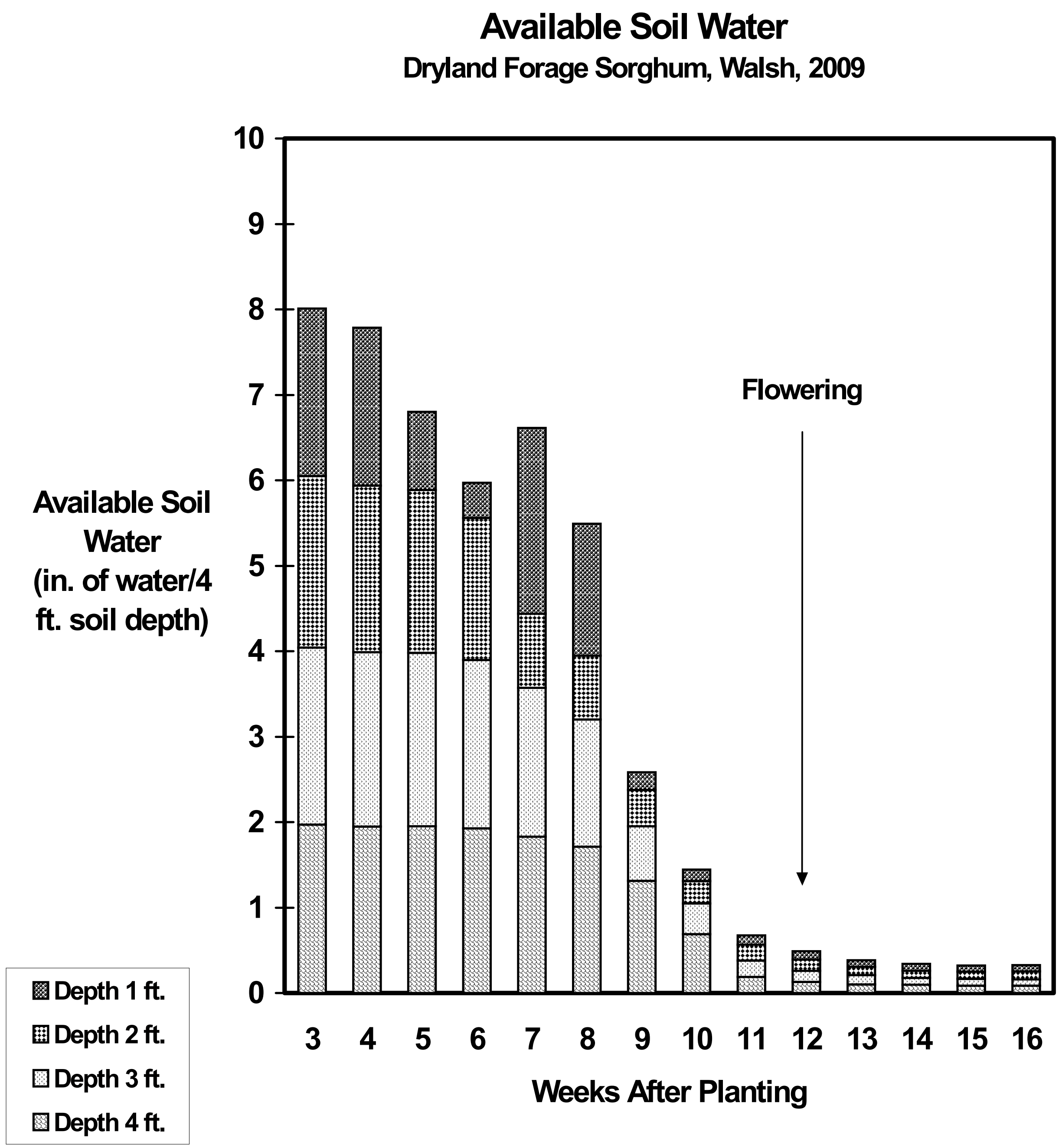

Fig. 3. Available soil water in dryland forage sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to harvest was 14.35 in. Any increase in available soil water between weeks is from rain.

Table 6.--Dryland Forage Sorghum Hybrid Performance Trial at Walsh, 2009. \1

Brand	Hybrid	Forage Type \2	Days to Emerg	Days to 50% Bloom	Harvest Density	Plant Ht.	Stage \3 at Harvest	Stem Sugar	Plant Lodg	Forage Yield	Yield % of Test Avg.
					plants/a (1000 X)	in		%	%	tons/a	%
SORGHUM PARTNERS	HIKANE II	FS	8	72	43.8	79	MT	13	2	16.1	119
SORGHUM PARTNERS	Sordan Headless	SS	9	107	47.6	83	FL	17	0	15.4	114
SORGHUM PARTNERS	NK300	FS	9	85	40.3	53	HD	18	0	15.1	112
SORGHUM PARTNERS	Trudan Headless	HS	9	101	41.8	89	FL	15	0	14.0	103
MISS. STATE UNIV.	Topper 76-6	SW	9	99	36.8	76	PM	20	0	13.9	102
SORGHUM PARTNERS	Sordan 79	SS	8	70	46.1	83	MT	13	25	13.7	101
(Check)	NB 305F	FS	11	85	22.1	65	SD	19	0	13.6	101
AERC	CSSH 45	SW	9	70	29.4	78	MT	16	12	11.4	84
SORGHUM PARTNERS	Trudan 8	HS	8	65	39.9	89	MT	11	12	11.2	82
PIONEER	33D49	Corn	7	70	26.7	72	SD	11	0	11.1	82
Average		FS	9	82	37.5	77	LM	15	5	13.5	
LSD 0.20										1.91	

\1 Planted: June 9; Harvested: October 26.

\2 Forage Type: FS, Forage Sorghum; SS, Sorghum Sudangrass; HS, Hybrid Sudangrass; SW, Sweet Sorghum.

\3 Harvest Stage: Veg, vegetative; BT, boot; FL, flowering; PM, premilk; EM, early milk; MM, midmilk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough; MT, mature.

Forage Yield adjusted to 70% moisture content based on oven-dried sample.

Table 7.--Summary: Dryland Forage Sorghum Hybrid Performance Tests at Walsh, 2007-2009.

		Forage Yield					Yield as % of Test Average				
Brand	Hybrid	2007	2008	2009	2-Year Avg	3-Year Avg	2007	2008	2009	2-Year Avg	3-Year Avg
		------------------tons/a------------------					---------------------%---------------------				
MISS. STATE UNIV.	M81-E	12.4	18.5	--	15.5	--	108	117	--	113	--
MISS. STATE UNIV.	Topper 76-6	12.3	15.9	13.9	14.9	14.0	107	100	102	101	103
MISS. STATE UNIV.	Dale	11.4	15.0	--	13.2	--	99	95	--	97	--
MISS. STATE UNIV.	Theis	9.7	14.1	--	11.9	--	85	89	--	87	--
SORGHUM PARTNERS	NK 300	13.1	19.0	15.1	17.1	15.7	112	120	112	116	115
SORGHUM PARTNERS	HIKANE II	12.5	15.5	16.1	15.8	14.7	107	98	119	109	108
SORGHUM PARTNERS	Sordan 79	11.2	15.1	13.7	14.4	13.3	96	96	101	99	98
SORGHUM PARTNERS	Sordan Headless	--	19.0	15.4	17.2	--	--	120	114	117	--
SORGHUM PARTNERS	Trudan Headless	--	19.0	14.0	16.5	--	--	120	103	112	--
(Check)	NB 305F	14.0	16.2	13.6	14.9	14.6	120	103	101	102	108
(Check)	Corn	6.7	15.9	11.1	13.5	11.2	57	101	82	92	80
Average		11.7	15.8	13.5	14.7	13.7					

Forage Yields were adjusted to 70% moisture content based on oven-dried sample.

The site was pre-irrigated with furrow irrigation in 2008.

Table 8.--Dryland Forage Sorghum Hybrid Dry Matter Analysis at Walsh, 2009.

Brand	Hybrid	Forage Type \1	Days to Boot	Boot Plant Ht	CP	ADF	NDF	TDN	RFV	Net Energy Main.	Net Energy Gain	Net Energy Lact.
				in	---------------%-------------------					-----MCal/lb-----		
SORGHUM PARTNERS	Sordan Headless	SS	97	69	5.8	33.5	49.3	64.4	119	0.66	0.39	0.66
MISS. STATE UNIV.	Topper 76-6	SW	90	70	6.2	34.0	51.9	63.8	112	0.65	0.39	0.66
SORGHUM PARTNERS	NK300	FS	77	40	10.5	34.0	52.1	63.8	111	0.65	0.39	0.66
SORGHUM PARTNERS	Trudan Headless	HS	92	72	5.6	35.6	53.3	62.0	107	0.63	0.36	0.64
MYCOGEN	2T828	Corn	65	73	11.7	35.5	55.2	62.1	103	0.63	0.36	0.64
(Check)	NB 305F	FS	74	55	10.7	35.3	55.6	62.3	103	0.63	0.37	0.64
SORGHUM PARTNERS	Trudan 8	HS	57	57	12.5	38.3	57.6	58.8	95	0.58	0.32	0.60
AERC	CSSH 45	SW	63	64	8.7	38.2	58.1	59.0	95	0.58	0.32	0.60
SORGHUM PARTNERS	HIKANE II	FS	65	62	9.1	38.9	60.6	58.2	90	0.57	0.31	0.59
SORGHUM PARTNERS	Sordan 79	SS	61	63	9.7	40.4	61.3	56.5	87	0.54	0.29	0.57
Sorghum Average		FS	74	63	9.1	36.4	55.5	61.1	102	0.61	0.35	0.63

\1 Forage Type: FS, Forage Sorghum; SS, Sorghum Sudangrass.

Infrared analysis performed on whole plant samples taken at boot.

CP, Crude Protein; ADF, Acid Detergent Fiber; NDF, Neutral Detergent Fiber; TDN, Total Digestible Nutrients;
RFV, Relative Feed Value; Net Energy: Maintenance, Gain, Lactation..

Irrigated Forage Sorghum Hybrid Performance Trial at Walsh, 2009

COOPERATORS: Plainsman Agri-Search Foundation, and Kevin Larson, Superintendent, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under irrigated conditions with 2550 sorghum heat units in a Silty Loam soil.

PLOT: Four rows with 30” row spacing, 50’ long. SEEDING DENSITY: 113,250 seed/a. PLANTED: June 8. HARVESTED: October 23.

EMERGENCE DATE: 9 days after planting. SOIL TEMP: 74 F.

IRRIGATION: Two furrow irrigations: July 10 and August 19, total applied 12 a-in./a.

PEST CONTROL: Preemergence Herbicides: Glyphosate 24 oz/a, 2,4-D 0.5 lb/a. Post Emergence Herbicides: Atrazine 1.0 lb/a, Banvel 4 oz/a, COC 32 oz/a. CULTIVATION: Once. INSECTICIDES: None.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------no. of days--------		
June	2.18	521	11	1	22
July	7.92	824	19	5	53
August	1.75	712	15	0	84
September	2.50	467	5	0	114
October	0.00	28	1	0	116
Total	14.35	2552	51	6	116

\1 Growing season from June 8 (planting) to October 2 (first freeze, 30F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

FIELD HISTORY: Last Crop: Cotton. FIELD PREPARATION: No-till.

COMMENTS: Planted in good soil moisture. Weed control was fair. Above normal precipitation for the growing season with a very wet July. No greenbug infestation. There was only minor lodging. Forage yields were good.

SOIL: Silty Loam for 0-8” and Silty Loam 8”-24” depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.6	1.0	2.0	41	4.3	442	0.7	2.9
8”-24”				43				
Comment	Alka	VLo	Hi	VHi	Lo	VHi	Lo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	40	2	0
Applied	50	20	0	0

Yield Goal: 18 ton/a.
Actual Yield: 20.0 ton/a @ 70% MC.

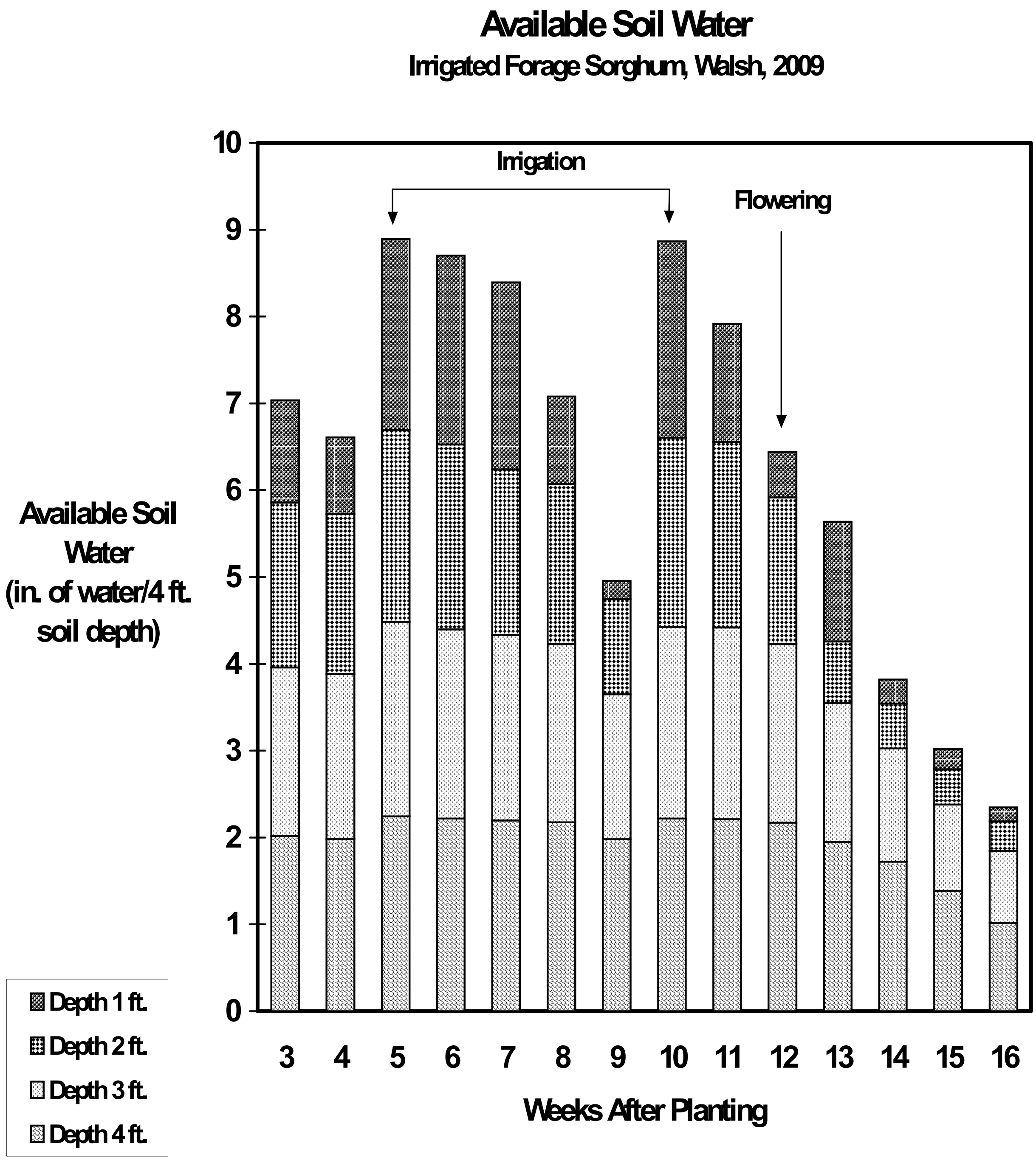

Fig. 4. Available soil water in irrigated forage sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to harvest was 14.35 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table 9.--Irrigated Forage Sorghum Hybrid Performance Trial at Walsh, 2009. \1

Brand	Hybrid	Forage Type \2	Days to Emerg	Days to 50% Bloom	Harvest Density	Plant Ht.	Stage \3 at Harvest	Stem Sugar	Plant Lodg	Forage Yield	Yield % of Test Avg.
					plants/a (1000 X)	in		%	%	tons/a	%
SORGHUM PARTNERS	Trudan Headless	HS	7	99	59.6	116	FL	14	0	22.0	110
SORGHUM PARTNERS	NK300	FS	7	84	54.6	77	HD	12	5	21.5	107
SORGHUM PARTNERS	Sordan Headless	SS	7	104	48.0	118	FL	14	0	21.4	107
(Check)	NB 305F	FS	7	85	29.8	90	SD	15	0	19.4	97
PIONEER	33D49	Corn	6	71	34.5	84	SD	9	0	18.4	92
AERC	CSSH 45	SW	7	71	42.2	89	MT	16	5	17.4	87
Average		FS	7	86	44.8	96	SD	13	2	20.0	
LSD 0.20										2.37	

\1 Planted: June 8; Harvested: October 23.

\2 Forage Type: FS, Forage Sorghum; SS, Sorghum Sudangrass; HS, Hybrid Sudangrass; SW, Sweet Sorghum.

\3 Harvest Stage: Veg, vegetative; BT, boot; FL, flowering; PM, premilk; EM, early milk; MM, midmilk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough; MT, mature.

Forage Yield adjusted to 70% moisture content based on oven-dried sample.

Table 10.--Summary: Irrigated Forage Sorghum Hybrid Performance Tests at Walsh, 2007-2009.

		Forage Yield					Yield as % of Test Average				
Brand	Hybrid	2007	2008	2009	2-Year Avg	3-Year Avg	2007	2008	2009	2-Year Avg	3-Year Avg
		-----------------tons/a-------------------					----------------------%---------------------				
MISS. STATE UNIV.	M81-E	27.9	17.2	--	22.6	--	118	102	--	110	--
MISS. STATE UNIV.	Topper 76-6	26.5	17.4	--	22.0	--	112	103	--	108	--
MISS. STATE UNIV.	Dale	24.4	18.2	--	21.3	--	103	108	--	106	--
MISS. STATE UNIV.	Theis	22.1	15.5	--	18.8	--	93	92	--	93	--
SORGHUM PARTNERS	NK 300	24.8	19.4	21.5	20.5	21.9	104	115	107	111	109
SORGHUM PARTNERS	HIKANE II	21.8	16.6	--	19.2	--	92	98	--	95	--
SORGHUM PARTNERS	Sordan 79	24.8	17.1	--	21.0	--	104	101	--	103	--
SORGHUM PARTNERS	Sordan Headless	--	19.4	21.4	20.4	--	--	115	107	111	--
SORGHUM PARTNERS	Trudan Headless	--	19.4	22.0	20.7	--	--	115	110	113	--
(Check)	NB 305F	25.6	16.4	19.4	17.9	20.5	108	97	97	97	101
(Check)	Corn	21.1	18.4	18.5	18.5	19.3	89	109	92	101	97
Average		23.7	16.9	20.0	18.5	20.2					

Forage Yields were adjusted to 70% moisture content based on oven-dried sample.

Table 11.--Irrigated Forage Sorghum Hybrid Dry Matter Analysis at Walsh, 2009.

Brand	Hybrid	Forage Type \1	Days to Boot	Boot Plant Ht	CP	ADF	NDF	TDN	RFV	Net Energy Main.	Net Energy Gain	Net Energy Lact.
				in	---------------%-------------------					-----MCal/lb-----		
MYCOGEN	2T828	Corn	66	81	8.8	38.6	58.7	58.5	93	0.57	0.32	0.60
SORGHUM PARTNERS	NK300	FS	76	55	8.6	40.1	59.3	56.8	90	0.55	0.29	0.58
SORGHUM PARTNERS	Sordan Headless	SS	94	94	5.6	42.3	62.5	54.3	83	0.51	0.26	0.55
(Check)	NB 305F	FS	75	61	7.6	40.8	64.7	56.0	82	0.54	0.28	0.57
SORGHUM PARTNERS	Trudan Headless	HS	90	94	5.3	43.6	62.8	52.9	81	0.49	0.23	0.53
AERC	CSSH 45	SW	64	69	6.7	43.4	64.1	53.0	80	0.49	0.24	0.54
Sorghum Average		FS	78	76	7.1	41.5	62.0	55.3	85	0.53	0.27	0.56

\1 Forage Type: FS, Forage Sorghum; SS, Sorghum Sudangrass.

Infrared analysis performed on whole plant samples taken at boot.

CP, Crude Protein; ADF, Acid Detergent Fiber; NDF, Neutral Detergent Fiber; TDN, Total Digestible Nutrients;
RFV, Relative Feed Value; Net Energy: Maintenance, Gain, Lactation..

Expanding Bio-based Energy Crop Options for Dryland Systems

Kevin Larson[1], Dennis Thompson, Deborah Harn, Timothy Macklin, and James Wittler

Sorghum is a well-adapted crop for the dryland areas in the Southern High Plains. The rural economies of this region depend on healthy and sustainable agricultural bases. Grain and forage sorghum production contributes to stabilizing these rural economies. Expanding the marketing crop options of sorghum by increasing its utilization for ethanol production would raise grower profit and bolster rural communities (Dept. of Energy, 2001). The development of high starch grain sorghum has the potential to increase ethanol yield (gallons of ethanol produced per bushel) by 40 to 50% (Seed Quest 2001; McLaren, et al., 2002). If higher ethanol yield gains were realized from high starch grain sorghum, these high starch grain sorghums would merit price premiums for growers.

Grain sorghum is not the only sorghum feedstock available for ethanol production in the Southern High Plains. The stalk juice of sweet forage sorghum is readily fermentable and requires much less energy for processing than ethanol made from grain (Undersander, et al., 1990). Because of the potential of sweet sorghum for higher per acre ethanol production and reduced energy conversion input, there is national interest in using sweet sorghum as an ethanol feedstock.

Brazil is an international example of ethanol's potential. Brazil has become energy independent by producing ethanol from the juice of sugarcane (Luhnow and Samor, 2006). Sugarcane production requires higher moisture conditions and longer growing seasons than are found in the Southern High Plains. Fortunately, many forage sorghums with high stalk sugar are adapted to the drier, shorter growing season conditions of our region (Larson, et al., 2004). One of our goals is to identify regionally adapted sweet sorghums with higher stalk sugar and potentially higher ethanol production than the adapted forage sorghums currently grown. Production of ethanol from grain and forage sorghum should increase the financial stability of both local ethanol plants and growers, while improving the economic stability of surrounding rural communities.

Materials and Methods

<u>Procedure: Forage and Sweet Sorghums, First Year, 2007</u>

Four sweet sorghum varieties and four forage sorghum hybrids were planted into a dryland no-till system on June 5, 2007. Early in the season, notes were taken at emergence and plant densities were measured. Gypsum block were install and soil moisture readings were recorded every week. To derive a formula to estimate *in situ* ethanol yield of these sweet and forage sorghums, we made forage yield estimates and stalk sugar content readings. For the forage yield estimates, we measured plant density, plant height, total nodes, and plant weight. To determine the internode that corresponds to percent sugar of entire stalk, we measured the 2nd, 4th, 6th, and 8th internodes for stalk diameter with a digital caliper and percent sugar with a hand refractometer at boot, flowering, early milk, and late milk. Plants were milled with a manual cane press to extract total stalk juice. This juice was weighed, volume determined, and refractometer readings taken for each hybrid/variety at all four developmental stages. When the seed of the forage sorghums reached early dough, plants were counted and harvested from 21.75 ft of one row and total stalk juice was hand milled from the plants. Plant density, plant weight, percent sugar, juice volume and weight were recorded. The same forage harvest was performed on the sweet sorghums; however, none of the sweet sorghum reached early dough development. Forage harvest for stalk juice extraction was performed on the sweet sorghums just before the site was harvested for silage. This entire dryland forage study was harvested with a silage chopper on October 2, 2007. The silage from each plot was weighed and a representative sample of each hybrid/variety was oven dried for moisture content and silage yields recorded at 70% moisture content.

To determine the ethanol production of the stalk juice pressed at early dough (or just before silage harvest for sweet sorghums), the juice was lowered to pH 4.8, yeast added and fermented for 5 days in an air locked container. We had planned to distill these wines and record volume and proof of the distilled alcohol; however, these musts did not completely ferment. We tried to restart these stalled fermentations by adding additional yeast and yeast nutrients (a mix of DAP and other nutrients), but they still did not complete their fermentations. We did not distill these sweet wines; therefore, the ethanol yields we used were potential and not actual ethanol yields.

Procedure: Forage and Sweet Sorghums, Second Year, 2008

Four sweet sorghum varieties and four forage sorghum hybrids were planted into a dryland no-till system on June 30, 2008. The site was pre-irrigated because there was insufficient winter and spring moisture for seed germination and growth. Early in the season, notes were taken at emergence and plant densities were measured. Gypsum block were install and soil moisture readings were recorded every week. To derive a formula to estimate *in situ* ethanol yield of these sweet and forage sorghums, we made forage yield estimates and stalk sugar content readings. For the forage yield estimates, we measured plant density, plant height, stalk diameter, and plant weight. To determine the internode that corresponds to percent sugar of entire stalk, we measured the 3^{nd}, 5^{th}, 7^{th}, and 9^{th} internodes for stalk diameter with a digital caliper and percent sugar with a hand refractometer at boot, flowering, milk, and dough (only one hybrid, Sordan 79, reached the dough stage). Plants were milled with a manual cane press to extract overall stalk juice. This juice was measured with refractometer to determine sugar percentage of overall stalk juice for each hybrid/variety at all four developmental stages, or the most advanced development stage at first freeze. Two plants were harvested at each developmental stage: the stalk of one plant was press for overall percent sugar, and the second plant was deconstructed and the leaves, head, and stalk were weighed and oven-dried to determine dry weight and plant moisture of leaves, head, and stalk. This entire dryland forage study was harvested with a silage chopper on October 27, 2008. The silage from each plot was weighed and a representative sample of each hybrid/variety was oven-dried for moisture content and silage yields were adjusted to 70% moisture content.

Last year, we found that our manual cane press would only expel an average of 17% of the theoretical stalk juice, and this varied greatly with stalk diameter. Our manual cane press was good for determining the overall Brix readings for the entire stalk, but not for total juice yields. We were unable to find a small-scale, commercially available hydraulic press that would produce commercially acceptable extraction levels of stalk juice. However, we did determine that total stalk sugar could be extracted by finely chopping the stalks, adding water, and heating the mixture to 80C for 30 minutes, then pressing the mixture with a fruit press to extract the juice (Larson, 2008). By repeating the above procedure on the same chopped stalks, we obtained stalk sugar amounts similar to theoretical stalk sugar amounts derived by Brix readings at the 6th internode and measuring stalk water (water loss from drying wet stalks). Stalk water divided by 100-Brix/100 is stalk juice. Stalk juice minus stalk water is stalk sugar.

To derive potential ethanol production of the sweet and forage sorghum hybrids, we converted the moisture adjusted silage yield obtained at each developmental stage to get dry silage yield, times the whole plant moisture to get wet silage yield, times the wet stalk to plant ratio to get wet stalk yield, times the stalk moisture to get stalk water, times the average Brix readings from the 5th and 7th internodes to get stalk juice (lb/a), divided by the juice conversion from pounds to gallons (0.335(Brix) + 8.325) to get stalk juice (gal/a), times potential ethanol (Brix(0.6)-1) to get potential ethanol yield (gal/a).

Procedure: Grain Sorghum, First and Second Years, 2007 and 2008

The first year, we planted five high starch and seven conventional starch grain sorghums into a dryland no-till system on June 5, 2007. The second year, we planted five high starch and six conventional starch grain sorghums into a no-till dryland system on June 10, 2008. In 2008, the site was pre-irrigated because there was insufficient winter and spring moisture for seed germination and growth. Early in the season, notes were taken at emergence and plant densities were measured. Gypsum block were install and soil moisture readings were recorded every week. For each hybrid, we recorded the date when 50% of the stalks flowered and the date when 50% of the stalk had mature seeds. At grain harvests (first year, October 29, 2007; second year, November 25, 2008), we measured plant height, plant lodging, and grain yield. We took grain samples from each hybrid and measured grain moisture and test weight. Grain yields are adjusted to 14% seed moisture content. From these grain samples we determined ethanol yield by milling the grain, adding water and enzymes and heating the mash to convert the starch into sugar, pitching in the yeast and fermenting the mash, pressing the beer from the mash, distilling the beer, and measuring the volume, weight and proof of the distill ethanol.

Results and Discussion

Results and Discussion: Forage and Sweet Sorghums

In 2007, refractometer readings of stalk juice were taken at the 2nd, 4th, 6th, and 8th internodes at boot, flowering, early milk, and late milk to determine which internode readings most closely corresponded to the percent sugar of the overall stalk juice. The percent sugar for total stalk juice for forage and sweet sorghums were best represented by the refractometer readings from the 6th and 8th internodes at all four developmental stages (Table 1). Although no measurements were taken from the 7th internode, linear analysis suggests that readings of the 7th internode provided the best representation of percent sugar for the whole stalk (Fig. 1).

In 2008, to better target the best corresponding internode, we took stalk readings at the 3rd, 5th, 7th and 9th internodes. The percent sugar for the overall stalk juice for forage and sweet sorghums was best represented by the refractometer readings from the 5th internode at all four developmental stages (Table 2). Reviewing the internode refractometer readings for the past two seasons indicated that the 6th internode provided the best representation of percent sugar for the whole stalk, 7th internode for 2007 and 5th internode for 2008, (Fig. 2).

The parameters we used to measure forage yield estimates were: 1) the average stalk diameter of the 6th internode (in.) for 2007 or the average of the 5th and 7th internodes (in.) for 2008, 2) stalk count from 11ft. of one row (2.5ft. x 11ft.), and 3) plant height (in.). To derive a constant for estimated silage yields based on these parameters, we used the parameter product divided by the silage yield calculated at each developmental stage. For both years, we found that developmental stages differentiated less than sorghum class (SS, Sorghum x Sudan; FS, Forage Sorghum; and SW, Sweet Sorghum). In 2007, the constants we derived for the sorghum classes from boot through late milk were 0.007838 for SS, 0.01054 for FS, and 0.006231 for SW (Table 3). In 2008, the constants we obtained for the sorghum classes from boot through soft dough were 0.004402 for SS, 0.005384 for FS, and 0.006262 for SW (Table 4). For each individual year, these constants times the parameter products provided good estimates of silage yields ($F(10,10) = 0.8529$, $P = 0.8063$ for 2007; $F(8,8) = 2.3496$, $P = 0.2483$ for 2008). However, the class constants that we calculated in 2008 were much lower than the constants obtained in 2007, except for the class constant for sweet sorghums (0.006262 in 2008, and 0.006231 in 2007). With the exception of the class constants for sweet sorghum, the class constants are too variable between years to provide reasonable estimates of silage yields.

Our stalk juice extraction rates were negligible and labor intensive with the manual cane press. Our average extraction rate was only 17% of the theoretical total stalk juice, i.e., the oven-dried water weight of the stalk, plus the stalk sugar weight (calculated from the Brix reading of the sixth internode) (Table 5). We were unsuccessful in acquiring a motorized hydraulic press, therefore, we could not simulate field juice extraction by swather pressing. Because of our low stalk juice extractions and incomplete fermentations, we reported potential ethanol production and not actual ethanol production.

In a related study, we obtained high stalk juice extraction rates by finely chopping the stalks, adding water, heating the chopped stalk and water mix at 80^{o}C for 30 minutes, and pressing the liquid out with a fruit press (Larson, 2008). By repeating this procedure on the same chopped stalk sample, we were able to reach the theoretical stalk sugar yield.

The final harvest juice constant for all the hybrids/varieties tested provided acceptable estimates of the potential ethanol yield for each individual year ($F(7,7) = 1.1535$, $P = 0.8554$ for 2007; $F(7,7) = 0.7334$, $P = 0.6928$ for 2008) (Tables 6 and 7). However, the large disparity we found between years for silage constants were also found for juice constants. In 2008, the juice constants were much larger than the juice constants obtained in 2007; for example, the average juice constants for sweet sorghums at final harvest were 193.2 for 2008 and 124.5 for 2007. The juice constants are too variable between years to provide reasonable estimates of juice yields and resultant ethanol yields.

The problems of predicting ethanol production were further compounded by our model's inability to predict silage yield and juice constants, since these were integral factors in the equation for estimating ethanol production. Our silage, juice, and ethanol production models, which we derived from plant height, plant density, stalk diameter, and stalk Brix measurements, did not provide adequate yield constants to make them suitable predictive tools between years.

In 2008, stalk juice production for forage sorghums peaked at flowering with an average of 3106 gal/a, whereas stalk juice production averaged similar amounts for boot and milk stages (Tables 8, 9, and 10).

Despite the curvilinear change in stalk juice production with advancing developmental stages, ethanol production for forage sorghums increased linearly with later developmental stages. Highest ethanol production occurred at final harvest, even with lower stalk juice production, because sugar levels increased with later development stages (Tables 11, 12, and 13). At final harvest in 2008, the average potential ethanol production was 220.8 gal/a for the forage sorghums, and 218.3 gal/a for the sweet sorghums (Table 7). At final harvest, all the sweet sorghums were in flowering and the average developmental stage for the forage sorghums was mid-milk. Tracking the ethanol production of Sorghum Partners Sordan 79, the only hybrid to reach all four developmental stages, we found that potential ethanol production increased with each progressive developmental stage sampled: boot (21.0 gal/a), flowering (56.3 gal/a), mid-milk (137.1 gal/a), and soft dough (146.7 gal/a) ($y = -56.3 + 77.9x – 6.4x^2$, $R^2 = 0.940$). Ethanol production increased nearly exponentially for the first three developmental stages, but was quite flat between mid-milk and soft dough. This indicates that the soft dough stage is near the optimum harvest stage for ethanol production.

Although we were unable to develop reasonable predictive tools for silage and ethanol yield, we were able to identify adapted sweet and forage sorghums with high ethanol production. At final harvest for both years, the top potential ethanol producing forage sorghum hybrid was NB 305F with an average of 222.0 gal/a. Of the sweet sorghums tested, Topper 76-6 had the highest average potential ethanol production, 229.7 gal/a (Tables 6 and 7). In 2007, there was less than 2 gal/a in potential ethanol production between the best forage sorghum hybrid, NB 305F, and the second best hybrid, Sorghum Partners HiKane II, and less than 1 gal/a of potential ethanol production separated the two best sweet sorghum varieties, Theis and Topper 76-6. In 2008, the differences in potential ethanol production among the forage sorghum hybrids and among the sweet sorghum varieties were much larger than we found the previous year. The difference between first and second in potential ethanol production was 45.3 gal/a for forage sorghums and 23.6 gal/a for sweet sorghums.

At final harvest in 2008, the average developmental stage of the forage sorghums was one full sample stage later than the developmental stage of the sweet sorghums (Table 7). The earlier developmental stage of the sweet sorghums may have contributed to the lack of ethanol production difference between the sweet sorghums and the forage sorghums at final harvest.

The earlier developmental stage at final harvest does not explain the results in 2007, where the potential ethanol production of sweet sorghums at final harvest averaged 59 gal/a more than the forage sorghums, even though their average developmental stage was earlier than the forage sorghums (Table 6). Late season dry weather in 2007 arrested the development of the sweet sorghum variety M81-E. The silage and ethanol productions of M81-E were still quite good despite its slowed development. Of the four sweet sorghums tested, M81-E appeared to be the least adapted to our dry conditions.

Results and Discussion: High Starch and Conventional Starch Grain Sorghums

The five high starch grain sorghums are designated by their NC+ brand. The high starch grain sorghums produced equivalent grain yields in 2007 and were within 5 bu/a in 2008 of the conventional starch grain sorghums (Tables 14 and 15). There was no difference in overall ethanol yield between high starch and conventional starch grain sorghum hybrids in 2007. Ethanol yield per bushel averaged identical yields of 2.42 gal/bu for both high starch and conventional starch grain sorghum hybrids in 2007, and only 0.01 gal/bu separated the average of the high starch and conventional starch hybrids in 2008. There were only minor differences in average total ethanol production, 0.1 gal/a in 2007 and 10 gal/a in 2008, between high starch and conventional starch grain sorghums. A comparison of the high starch to conventional-starch grain sorghums revealed that there were minimal differences between the average grain yield, ethanol yield (gal/bu), and total ethanol production (gal/a) for the two years of this study. There appears to be no ethanol production advantage with high starch grain sorghums compared to conventional starch grain sorghums, and therefore, high starch grain sorghums do not warrant price premiums.

As part of our study, we planned to compare a high starch grain sorghum to a conventional starch grain sorghum under commercial ethanol production conditions in a nearby ethanol facility. Conditions were extremely dry at planting in 2008; therefore, we chose NC+ 5B89 for this farm scale, high starch grain sorghum comparison. We selected NC+ 5B89 because it was the highest yielding, early maturing, high starch grain sorghum hybrid tested in 2007. Unfortunately, the ethanol plant at Walsh ceased operations before we could compare high starch and conventional starch grain under commercial ethanol production conditions.

Conclusions

We found that a Brix reading from the 6th internode was a good representative for percent sugar in the juice of the entire stalk.

Our predictive models for silage yield, juice yield, and ethanol production were valid within their respective year, but were not suitable across years.

The manual cane press we used only extracted a small percentage of total stalk juice. Nonetheless, in a related study, we discovered that total juice extraction was achievable by finely chopping stalks, heating them with water, and pressing the diluted juice out with a fruit press.

We identified NB 305F, a forage sorghum, and Topper 76-6, a sweet sorghum, as adapted and high ethanol producing sorghums.

The high starch grain sorghum hybrids did not produce higher average grain yields, higher ethanol yields, or higher ethanol production than the standard starch grain sorghums. Without higher ethanol yield, none of the high starch grain sorghum would garner price premiums.

Ethanol production from forage and sweet sorghums averaged 50% more ethanol per acre than ethanol produced from grain sorghum. To take advantage of increased ethanol production of forage and sweet sorghums would require renovation of existing ethanol plants or construction of new plants to handle both grain and forage sorghum feedstocks. With greater feedstock diversity and lower operating costs, these hybrid ethanol facilities may become more profitable, while expanding the energy crop options and income of sorghum growers.

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Figures and Tables:

Table 1.-Internode Brix Reading Compared to Whole Stalk Juice Brix Reading, Walsh, 2007.

Hybrid	----------Internode 2	4	6	8---------	**Whole Stalk**	----------internode 2	4	6	8----------
	---------------%sugar				----------------	----difference from actual			----
Boot									
Sordan 79	7.6	8.0	6.4	7.8	**8.0**	-0.4	0.0	-1.6	-0.2
HiKane II	7.2	7.6	6.0	6.2	**7.2**	0.0	0.4	-1.2	-1.0
NB 305F	5.2	6.6	7.8	9.0	**10.2**	-5.0	-3.6	-2.4	-1.2
NK 300	8.0	8.8	9.8	10.6	**11.0**	-3.0	-2.2	-1.2	-0.4
Average	7.0	7.8	7.5	**8.4**	**9.1**	-2.1	-1.4	-1.6	**-0.7**
Flowering									
Sordan 79	8.8	10.0	10.0	12.0	**11.6**	-2.8	-1.6	-1.6	0.4
HiKane II	9.8	10.2	10.6	12.4	**11.6**	-1.8	-1.4	-1.0	0.8
NB 305F	10.2	11.0	13.4	13.6	**11.8**	-1.6	-0.8	1.6	1.8
NK 300	9.8	11.0	11.4	13.2	**12.2**	-2.4	-1.2	-0.8	1.0
Average	7.2	7.8	**8.5**	9.5	**8.8**	-1.6	-1.0	**-0.3**	0.8
Early Milk									
Sordan 79	10.8	10.8	12.6	14.2	**13.0**	-2.2	-2.2	-0.4	1.2
HiKane II	12.6	11.8	12.0	13.0	**13.0**	-0.4	-1.2	-1.0	0.0
NB 305F	16.4	15.6	19.2	20.8	**19.2**	-2.8	-3.6	0.0	1.6
NK 300	12.2	12.6	15.2	15.0	**15.8**	-3.6	-3.2	-0.6	-0.8
Average	13.0	12.7	**14.8**	**15.8**	**15.3**	-2.3	-2.6	**-0.5**	**0.5**
Late Milk									
Sordan 79	9.2	10.4	11.8	16.4	**13.8**	-4.6	-3.4	-2.0	2.6
HiKane II	8.6	9.0	11.8	12.2	**11.8**	-3.2	-2.8	0.0	0.4
NB 305F	7.0	7.4	10.0	10.4	**10.2**	-3.2	-2.8	-0.2	0.2
NK 300	12.8	13.4	15.2	15.4	**15.4**	-2.6	-2.0	-0.2	0.0
Average	9.4	10.1	**12.2**	13.6	**12.8**	-3.4	-2.8	**-0.6**	0.8
Boot									
Theis	11.2	11.2	11.8	14.8	**13.0**	-1.8	-1.8	-1.2	1.8
Dale	11.4	13.8	16.8	17.2	**15.0**	-3.6	-1.2	1.8	2.2
Topper 76	16.8	19.0	19.2	15.0	**18.4**	-1.6	0.6	0.8	-3.4
M81E	13.8	14.8	15.0	15.2	**16.2**	-2.4	-1.4	-1.2	-1.0
Average	13.3	14.7	**15.7**	15.6	**15.7**	-2.4	-0.9	**0.0**	-0.1
Flowering									
Theis	11.8	13.2	15.0	17.0	**15.0**	-3.2	-1.8	0.0	2.0
Dale	14.4	17.6	20.8	20.4	**19.0**	-4.6	-1.4	1.8	1.4
Average	13.1	15.4	**17.9**	18.7	**17.0**	-3.9	-1.6	**0.9**	1.7
Early Milk									
Theis	12.8	14.2	15.4	17.2	**15.8**	-3.0	-1.6	**-0.4**	1.4
Average	10.8	11.8	**13.1**	14.1	**13.5**	-2.7	-1.7	**-0.4**	0.6

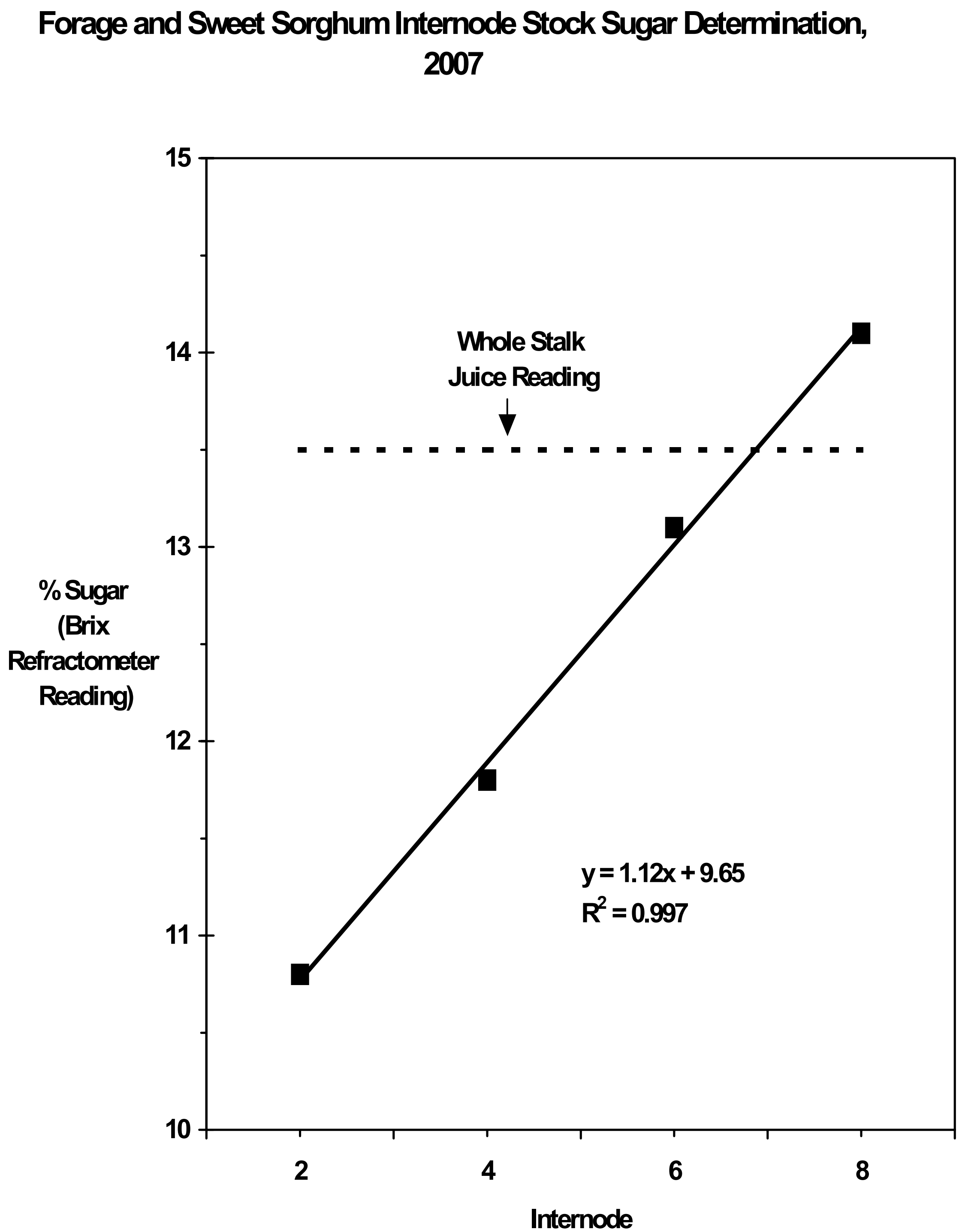

Fig. 1. Forage and sweet sorghum internode stalk sugar determination, 2007. Average Brix readings (% sugar) of stalk juice from four forage and four sweet sorghum hybrids were taken from boot to late milk at 2, 4, 6, and 8 internodes and compared to whole stalk juice readings.

Table 2.-Internode Brix Reading Compared to Whole Stalk Juice Brix Reading, Walsh, 2008.

Hybrid	Internode 3	Internode 5	Internode 7	Internode 9	**Whole Stalk**	internode 3	internode 5	internode 7	internode 9
	%sugar					difference from actual			
Boot									
Sordan 79	2.8	3.9	4.3	6.0	**4.4**	-1.6	-0.5	-0.1	1.6
HiKane II	3.6	3.9	4.9	6.9	**4.6**	-1.0	-0.7	0.3	2.3
NB 305F	7.3	8.4	7.1	6.3	**6.7**	0.6	1.7	0.4	-0.4
NK 300	6.9	7.6	8.7	7.1	**7.8**	-0.9	-0.2	0.9	-0.7
Average	5.2	**6.0**	6.3	6.6	**5.9**	-0.7	**0.1**	0.4	**0.7**
Flowering									
Sordan 79	4.4	5.5	5.8	6.4	**5.3**	-0.9	0.2	0.5	1.1
HiKane II	5.8	7.2	8.3	8.6	**8.4**	-2.6	-1.2	-0.1	0.2
NB 305F	11.2	13.9	14.2	10.5	**12.5**	-1.3	1.4	1.7	-2.0
NK 300	10.3	11.5	12.0	10.5	**12.0**	-1.7	-0.5	0.0	-1.5
Average	7.9	**9.5**	10.1	9.0	**9.6**	-1.6	**0.0**	0.5	-0.6
Milk									
Sordan 79	8.4	11.5	13.8	15.1	**12.1**	-3.7	-0.6	1.7	3.0
HiKane II	14.5	15.4	14.8	16.9	**16.5**	-2.0	-1.1	-1.7	0.4
NB 305F	15.0	16.9	18.7	18.9	**18.8**	-3.8	-1.9	-0.1	0.1
Average	12.6	14.6	**15.8**	17.0	**15.8**	-3.2	-1.2	**0.0**	1.2
Soft Dough									
Sordan 79	9.0	9.8	**11.6**	13.6	**11.5**	-2.5	-1.7	**0.1**	2.1
Boot									
Theis	8.5	9.9	8.8	8.7	**9.4**	-0.9	0.5	-0.6	-0.7
Dale	9.4	11.5	10.6	8.3	**8.3**	1.1	3.2	2.3	0.0
Topper 76	10.0	12.0	8.8	7.3	**10.2**	-0.2	1.8	-1.4	-2.9
M81E	6.6	8.8	7.1	7.5	**8.5**	-1.9	0.3	-1.4	-1.0
Average	8.6	10.6	**8.8**	8.0	**9.1**	-0.5	1.5	**-0.3**	-1.2
Flowering									
Theis	10.8	12.9	15.5	15.5	**13.8**	-3.0	-0.9	1.7	1.7
Dale	11.0	12.8	14.9	14.2	**13.1**	-2.1	-0.3	1.8	1.1
Topper 76	13.4	16.0	16.9	17.0	**15.4**	-2.0	0.6	1.5	1.6
M81E	8.4	10.2	11.0	11.3	**10.2**	-1.8	0.0	0.8	1.1
Average	10.9	**13.0**	14.6	14.5	**13.1**	-2.2	**-0.2**	1.5	1.4
Average	**9.0**	**10.6**	**11.2**	**11.4**	**10.8**	**-1.8**	**-0.3**	**0.4**	**0.6**

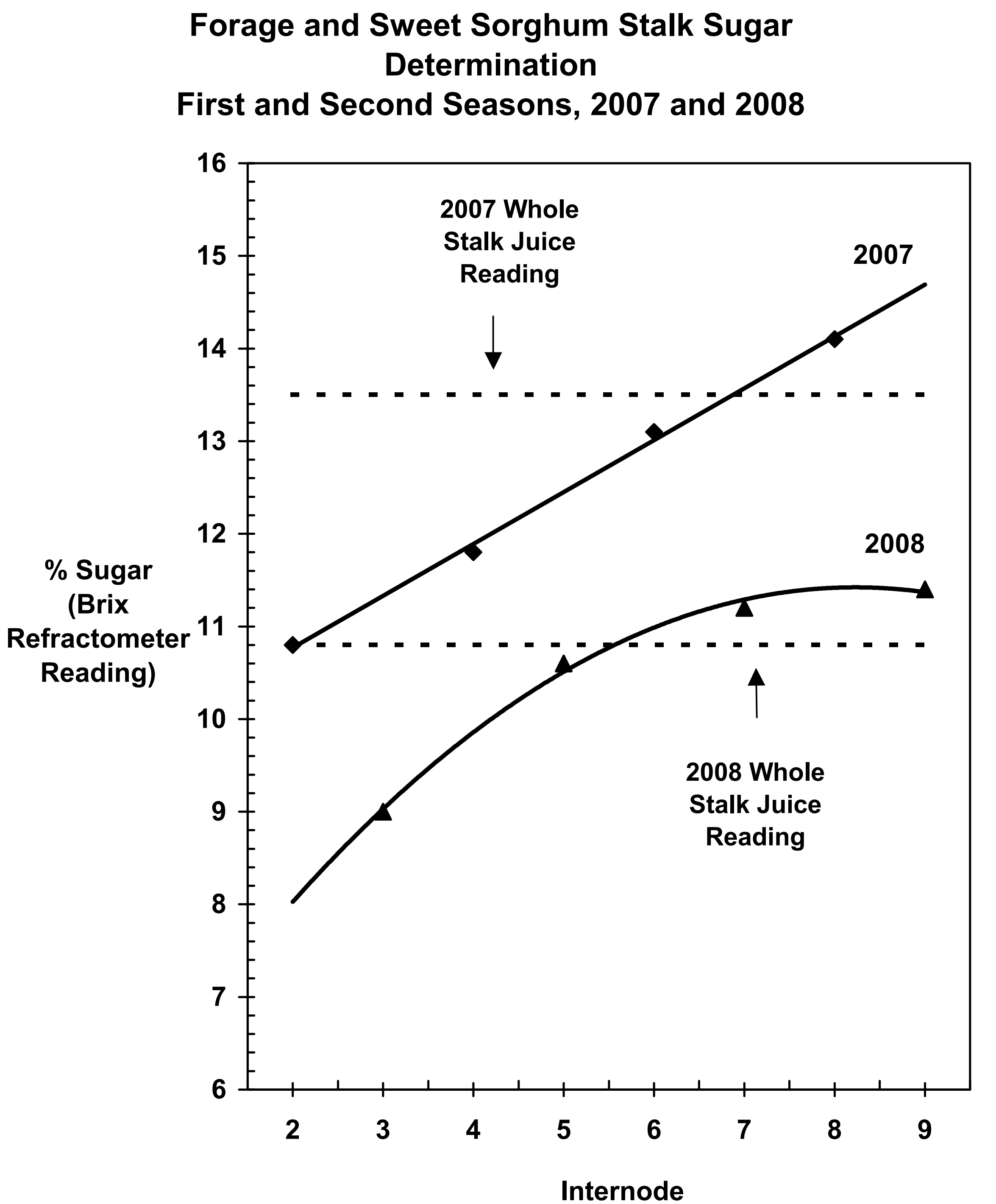

Fig. 2. Forage and sweet sorghum internode stalk sugar determination. Average Brix readings (% sugar) of stalk juice from four forage and four sweet sorghum hybrids were taken from boot to soft dough at 2, 4, 6, and 8 internodes for 2007 and 3, 5, 7, and 9 internodes for 2008 and compared to whole stalk juice readings.

Table 3.-Dryland Forage and Sweet Sorghums, Parameters and Constants for Silage Estimate, 2007.

Sorghum Class	Developmental Stage	Measured Parameters Product	Measured Silage Yield	Developmental Stage Constant	Measured Parameters Product	Class Constant	Estimated Silage Yield
			tons/a				tons/a
SS	Boot	1427.3	11.74	0.008225	1427.3	0.007721	11.02
SS	Flower	1676.1	10.08	0.006014	1676.1	0.007721	12.94
SS	Early Milk	1297.6	10.88	0.008385	1297.6	0.007721	10.02
SS	Late Milk	1261.6	11.01	0.008727	1261.6	0.007721	9.74
Average SS		**1415.7**	**10.93**	**0.007721**	**1415.7**	**0.007721**	**10.93**
FS	Boot	1187.4	11.86	0.01042	1187.4	0.01039	12.34
FS	Flower	1475.9	14.09	0.00967	1475.9	0.01039	15.33
FS	Early Milk	1310.7	13.66	0.01042	1310.7	0.01039	13.62
FS	Late Milk	1341.2	15.63	0.01178	1341.2	0.01039	13.94
Average FS		**1328.8**	**13.81**	**0.01039**	**1328.8**	**0.01039**	**13.81**
SW	Boot	1663.4	11.49	0.007013	1663.4	0.006168	10.26
SW	Flower	1883.5	10.6	0.005611	1883.5	0.006168	11.62
SW	Early Milk	2061.4	12.51	0.006069	2061.4	0.006168	12.71
Average SW		**1869.4**	**11.53**	**0.006168**	**1869.4**	**0.006168**	**11.53**

Sorghum Class: SS, Sorghum X Sudan Grass; FS, Forage Sorghum; SW, Sweet Sorghum.
Measured Parameters: sixth internode diameter (in.) x stalk count (11ft of one row, 2.5ft. x 11ft.); x plant height (in.).
Silage Yield: tons/a at 70% moisture content based on oven-dried sample.

Table 4.-Dryland Forage and Sweet Sorghums, Parameters and Constants for Silage Estimate, 2008.

Sorghum Class	Developmental Stage	Measured Parameters Product	Measured Silage Yield	Developmental Stage Constant	Measured Parameters Product	Class Constant	Estimated Silage Yield
			tons/a				tons/a
SS	Boot	1562.4	4.26	0.002727	1562.4	0.004402	6.88
SS	Flower	2049.0	7.94	0.003875	2049.0	0.004402	9.02
SS	Milk	2726.5	12.98	0.004761	2726.5	0.004402	12.00
SS	Soft Dough	2821.5	15.13	0.005362	2821.5	0.004402	12.42
Average SS		**2289.9**	**10.08**	**0.004402**	**2289.9**	**0.004402**	**10.08**
FS	Boot	1765.9	8.44	0.004778	1765.9	0.005384	9.51
FS	Flower	2293.3	12.75	0.005544	2293.3	0.005384	12.35
FS	Milk	2822.0	15.86	0.005620	2822.0	0.005384	15.19
Average FS		**2293.7**	**12.35**	**0.005384**	**2293.7**	**0.005384**	**12.35**
SW	Boot	1867.1	10.28	0.005541	1867.1	0.006262	11.69
SW	Flower	2310.6	15.87	0.006945	2310.6	0.006262	14.47
Average SW		**2088.9**	**13.08**	**0.006262**	**2088.9**	**0.006262**	**13.08**

Sorghum Class: SS, Sorghum X Sudan Grass; FS, Forage Sorghum; SW, Sweet Sorghum.
Measured Parameters: average of fifth and seventh internode diameters (in.) x stalk count (11ft of one row, 2.5ft. x 11ft.) x plant height (in.).
Silage Yield: tons/a at 70% moisture content based on oven-dried sample.

Table 5.-Dryland Forage and Sweet Sorghums, Single Plant Stalk Juice Yield, Walsh, 2007.

Brand	Hybrid/ Variety	Stage	Plant Density	Single Plant Stalk Juice	Stalk Sugar	Actual Stalk Juice Yield	Ethanol Prod.	Potent. Stalk Juice Yield	Potential Ethanol Production
			plants/a X1000	ml	%	gal/a	gal/a	gal/a	gal/a
	Corn								
Mycogen	2T801	Tassel	28.5	13	11	98	5.9	1178	71.3
	Forage Sorghum								
Sorghum Partners	Sordan 79	Boot	74.5	15	8	295	13.0	1696	74.6
Sorghum Partners	HiKane II	Boot	74.5	23	7.2	453	17.9	1396	55.3
(Check)	NB 305F	Boot	60.2	29	10.2	462	25.9	3065	172.0
Sorghum Partners	NK300	Boot	63.4	16	11	268	16.2	2629	159.1
	Sweet Sorghum								
Miss. State Univ.	Theis	Boot	44.4	60	13	704	50.3	3294	235.5
Miss. State Univ.	Dale	Boot	57.0	81	15	1222	100.8	4603	379.8
Miss. State Univ.	Topper 76-6	Boot	50.7	44	18.4	590	59.7	4228	427.9
Miss. State Univ.	M81-E	Pre Boot	44.4	31	16.2	364	32.4	3718	331.3
	Corn								
Mycogen	2T801	Silk	31.7	19	11	159	9.6	2693	162.9
	Forage Sorghum								
Sorghum Partners	Sordan 79	Flower	61.8	15	11.6	245	15.6	1435	91.5
Sorghum Partners	HiKane II	Flower	58.6	19	11.6	295	18.8	1918	122.4
(Check)	NB 305F	Flower	55.4	66	11.8	968	62.8	3428	222.5
Sorghum Partners	NK300	Flower	64.9	39	12.2	670	45.0	3739	250.9
	Sweet Sorghum								
Miss. State Univ.	Theis	Flower	44.4	65	15	763	62.9	3529	291.2
Miss. State Univ.	Dale	Flower	53.9	63	19	898	93.8	4557	476.2
	Corn								
Mycogen	2T801	Early Milk	25.3	19	12.2	127	8.6	2147	144.1
	Forage Sorghum								
Sorghum Partners	Sordan 79	Early Milk	57.0	19	13	287	20.5	1505	107.6
Sorghum Partners	HiKane II	Early Milk	53.9	32	13	456	35.6	2447	174.9
(Check)	NB 305F	Early Milk	47.5	63	19.2	792	83.6	3221	340.2
Sorghum Partners	NK300	Early Milk	50.7	18	15.8	241	21.0	2083	181.0
	Sweet Sorghum								
Miss. State Univ.	Theis	Early Milk	41.2	55	15.8	599	52.1	4276	371.6
	Corn								
Mycogen	2T801	Late Milk	23.8	33	11.2	207	12.8	2695	166.0
	Forage Sorghum								
Sorghum Partners	Sordan 79	Late Milk	50.7	18	13.8	241	18.3	1240	94.1
Sorghum Partners	HiKane II	Late Milk	53.9	24	11.8	342	22.2	2532	164.3
(Check)	NB 305F	Late Milk	55.4	41	10.2	601	33.7	2936	164.7
Sorghum Partners	NK300	Late Milk	53.9	24	15.4	342	29.0	3179	269.3
Average			51.2	35	13	470	35.9	2791	211.2

Table 6.-Dryland Forage and Sweet Sorghums, Final Harvest Silage, Stalk Juice Production, and Ethanol Production, Walsh, 2007.

Brand	Hybrid/ Variety	Stage	Stalk Sugar	Silage Yield	Actual Stalk Juice Yield	Ethanol Prod.	Juice Factor	Potential Stalk Juice Yield	Potential Ethanol Prod.	Final Harvest Juice Factor	Estimated Juice Yield	Estimated Ethanol Production
			%	ton/a	gal/a	gal/a		gal/a	gal/a		gal/a	gal/a
Forage Sorghum												
Sorghum Partners	Sordan 79	ED	12.9	15.1	154.3	10.9	128.1	1935	137.3	115.3	1742	123.6
Sorghum Partners	Hi-Kane II	ED	14.0	18.8	348.8	26.9	113.0	2119	163.2	115.3	2162	166.5
(Check)	NB 305F	ED	15.7	20.9	364.7	31.5	91.7	1912	165.1	115.3	2405	207.7
Sorghum Partners	NK300	ED	14.0	16.0	121.6	9.4	91.5	1464	112.7	115.3	1845	142.0
Forage Sorghum Average		**ED**	**14.2**	**17.7**	**247.4**	**19.7**	**106.1**	**1858**	**144.6**	**115.3**	**2039**	**160.0**
Sweet Sorghum												
Miss. State Univ.	Theis	EM	16.0	17.2	289.9	25.5	141.2	2432	214.0	115.3	1985	174.7
Miss. State Univ.	Dale	FL	17.3	19.2	371.5	35.3	104.1	1995	189.8	115.3	2210	210.3
Miss. State Univ.	Topper 76-6	BT	20.8	16.4	166.7	19.1	113.4	1865	213.3	115.3	1896	216.8
Miss. State Univ.	M 81-E	Pre BT	15.2	16.9	173.4	14.5	139.2	2358	197.1	115.3	1953	163.3
Sweet Sorghum Average		**FL**	**17.3**	**17.4**	**250.4**	**23.6**	**124.5**	**2162**	**203.6**	**115.3**	**2011**	**191.3**
Average			15.7	17.6	248.9	21.6	115.3	2010	174.1	115.3	2025	175.6
LSD 0.20			0.84	2.82	66.4							

Planted: June 5 at 69.7 seeds/a x 1000. Harvest Area: 21.75 ft. x 2.5 ft.
Stage: Pre BT, pre boot; BT, boot; FL, flowering; EM, early milk; LM, late milk; ED, early dough.
Silage Yield was adjusted to 70% moisture content based on oven-dried sample.
Juice Factor is the product of all the conversions from Silage Yield (tons/a @ 70% MC) to Potential Juice Yield (gal/a).
Ethanol Production is Brix(0.55)/100 times Juice Yield.

Table 7.-Dryland Forage and Sweet Sorghums, Final Harvest Silage and Potential Ethanol Production, Walsh, 2008.

Brand	Hybrid/ Variety	Harvest Stage	Silage Yield	Juice Factor	Juice Yield	Stalk Brix Reading	Potential Alcohol	Potential Ethanol Prod.	Final Harvest Juice Factor	Estimated Juice Yield	Estimated Ethanol Production
			tons/a 70% MC		gal/a	%	% v/v	gal/a		gal/a	gal/a
Forage Sorghum											
Sorghum Partners	Sordan 79	SD	15.13	178.9	2707	10.7	5.42	146.7	188.8	2857	154.8
Sorghum Partners	Hi-Kane II	MM	15.48	179.4	2778	15.1	8.06	223.9	188.8	2923	235.6
(Check)	NB 305F	MM	16.24	177.4	2881	17.8	9.68	278.9	188.8	3066	296.8
Sorghum Partners	NK300	FL	18.99	202.3	3841	11.8	6.08	233.6	188.8	3585	218.0
Forage Sorghum Average		**MM**	**16.46**	**184.5**	**3052**	**13.9**	**7.31**	**220.8**	**188.8**	**3108**	**226.3**
Sweet Sorghum											
Miss. State Univ.	Theis	FL	14.14	187.7	2654	14.2	7.52	199.6	188.8	2670	200.8
Miss. State Univ.	Dale	FL	15.03	185.9	2794	13.9	7.34	205.1	188.8	2838	208.3
Miss. State Univ.	Topper 76-6	FL	15.85	174.4	2765	16.5	8.90	246.1	188.8	2992	266.3
Miss. State Univ.	M 81-E	FL	18.47	224.7	4150	10.6	5.36	222.5	188.8	3487	186.9
Sweet Sorghum Averge		**FL**	**15.87**	**193.2**	**3091**	**13.8**	**7.28**	**218.3**	**188.8**	**2997**	**215.6**
Overall Average			16.17	188.8	3071	13.8	7.30	219.6	188.8	3052	220.9
LSD 0.20			2.87								

Planted: June 30 at 69.7 seeds/a x 1000; Silage Harvested: October 27.
Harvest Stage: BT, boot; FL, flowering; PM, pre-milk; EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough.
Juice Factor is the product of all the conversions from Silage Yield (tons/a @ 70% MC) to Juice Yield (gal/a).
Stock Brix Reading is the average refractometer juice reading from the 5th and 7th internodes.
Potential Ethanol Production is Juice Yield times potential alcohol % v/v, Brix(0.6)-1.

Table 8.–Forage and Sweet Sorghums: Silage, Plant Measurements, and Juice Factor Determinations at Boot, 2008.

Hybrid/ Variety	Silage Yield	Dry Silage Yield	Whole Plant Moist.	Wet Silage Yield	Wet Stalk to Plant	Wet Stalk Yield	Stalk Moist.	Stalk Water	Stalk Brix Reading	Stalk Sugar Yield	Stalk Juice Yield	Stalk Juice Conver.	Stalk Juice Yield	Juice Factor
	tons/a (70% MC)	lb/a	ratio	lb/a	ratio	lb/a	ratio	lb/a	%	lb/a	lb/a	lb/gal	gal/a	
Sordan 79	4.26	2556	0.8531	17400	0.7638	13290	0.8791	11683	4.1	500	12183	8.4624	1440	338.0
Hi-Kane II	7.38	4428	0.8618	32041	0.7646	24499	0.8914	21838	4.4	1005	22843	8.4724	2696	365.2
NB 305F	8.69	5214	0.8529	35445	0.7209	25553	0.8662	22134	7.8	1872	24006	8.5863	2797	321.8
NK 300	9.24	5544	0.8397	34585	0.6236	21567	0.8684	18729	8.2	1673	20402	8.5997	2373	256.8
FS Average	**7.39**	**4436**	**0.8519**	**29868**	**0.7182**	**21227**	**0.8763**	**18596**	**6.1**	**1263**	**19859**	**8.5302**	**2327**	**320.5**
Theis	10.62	6372	0.8101	33554	0.7870	26407	0.8299	21915	9.4	2275	24190	8.6399	2799	263.5
Dale	8.85	5310	0.8127	28350	0.7524	21331	0.8363	17838	11.1	2229	20067	8.6969	2308	260.8
Topper 76-6	11.3	6780	0.8150	36649	0.7281	26684	0.8342	22260	10.4	2584	24844	8.6734	2865	253.5
M 81-E	10.35	6210	0.8264	35772	0.7729	27648	0.8441	23338	8.0	2030	25368	8.5930	2953	285.3
SW Average	**10.28**	**6168**	**0.8161**	**33581**	**0.7601**	**25518**	**0.8361**	**21338**	**9.7**	**2280**	**23617**	**8.6508**	**2731**	**265.8**
BT Average	8.84	5302	0.8340	31725	0.7392	23372	0.8562	19967	7.9	1771	21738	8.5905	2529	293.1

Whole Plant Moisture and Stalk Moisture are from oven-dried deconstructed plant sample.
Wet Stalk to Plant ratio is from deconstructed plant sample.
Stalk Juice Yield (lb/a) is Stalk Water divide by 100-Brix/100.
Stalk Juice Conversion (lb/gal) is Stalk Juice Yield (lb/a) divided by lb/gal at various Brix readings, 0.335(Brix) + 8.325 lb/gal, i.e., stalk sugar + stalk water in lb/gal.
Stalk Juice Yield (gal/a) is Stalk Juice Yield (lb/a) divided by Stalk Juice Conversion (lb/gal).
Juice Factor is Stalk Juice Yield (gal/a) divided by Silage Yield (tons/a @ 70% MC).

Table 9.–Forage and Sweet Sorghums: Silage, Plant Measurements, and Juice Factor Determinations at Flowering, 2008.

Hybrid/ Variety	Silage Yield	Dry Silage Yield	Whole Plant Moist.	Wet Silage Yield	Wet Stalk to Plant	Wet Stalk Yield	Stalk Moist.	Stalk Water	Stalk Brix Reading	Stalk Sugar Yield	Stalk Juice Yield	Stalk Juice Conver.	Stalk Juice Yield	Juice Factor
	tons/a (70% MC)	lb/a	ratio	lb/a	ratio	lb/a	ratio	lb/a	%	lb/a	lb/a	lb/gal	gal/a	
Sordan 79	7.94	4764	0.8369	29209	0.7324	21393	0.8735	18687	5.7	1128	19815	8.5160	2326	293.0
Hi-Kane II	10.85	6510	0.8296	38204	0.7784	29738	0.8567	25477	7.8	2155	27632	8.5863	3219	296.7
NB 305F	13.68	8208	0.7833	37878	0.7533	28533	0.8038	22935	14.1	3764	26699	8.7974	3036	221.9
NK 300	18.99	11394	0.7861	53268	0.6751	35961	0.8214	29539	11.8	3952	33491	8.7203	3841	202.3
FS Average	**12.87**	**7719**	**0.8090**	**39640**	**0.7348**	**28906**	**0.8389**	**24160**	**9.9**	**2750**	**26909**	**8.6550**	**3106**	**253.5**
Theis	14.14	8484	0.7405	32694	0.8127	26570	0.7543	20042	14.2	3317	23359	8.8007	2654	187.7
Dale	15.03	9018	0.7510	36217	0.7720	27960	0.7561	21140	13.9	3412	24552	8.7907	2794	185.9
Topper 76-6	15.85	9510	0.7399	36563	0.7497	27411	0.7480	20504	16.5	4051	24555	8.8778	2765	174.4
M 81-E	18.47	11082	0.7799	50350	0.7999	40275	0.7997	32208	10.6	3820	36028	8.6801	4150	224.7
SW Average	**15.87**	**9524**	**0.7528**	**38956**	**0.7836**	**30554**	**0.7645**	**23474**	**13.8**	**3650**	**27124**	**8.7873**	**3091**	**193.2**
FL Average	14.37	8621	0.7809	39298	0.7592	29730	0.8017	23817	11.8	3200	27016	8.7212	3098	223.3

Whole Plant Moisture and Stalk Moisture are from oven-dried deconstructed plant sample.
Wet Stalk to Plant ratio is from deconstructed plant sample.
Stalk Juice Yield (lb/a) is Stalk Water divide by 100-Brix/100.
Stalk Juice Conversion (lb/gal) is Stalk Juice Yield (lb/a) divided by lb/gal at various Brix readings, 0.335(Brix) + 8.325 lb/gal, i.e., stalk sugar + stalk water in lb/gal.
Stalk Juice Yield (gal/a) is Stalk Juice Yield (lb/a) divided by Stalk Juice Conversion (lb/gal).
Juice Factor is Stalk Juice Yield (gal/a) divided by Silage Yield (tons/a @ 70% MC).

Table 10. Forage and Sweet Sorghums: Silage, Plant Measurements, and Juice Factor Determinations at Milk and Dough, 2008.

Hybrid/ Variety	Silage Yield	Dry Silage Yield	Whole Plant Moist.	Wet Silage Yield	Wet Stalk to Plant	Wet Stalk Yield	Stalk Moist.	Stalk Water	Stalk Brix Reading	Stalk Sugar Yield	Stalk Juice Yield	Stalk Juice Conver.	Stalk Juice Yield	Juice Factor
	tons/a (70% MC)	lb/a	ratio	lb/a	ratio	lb/a	ratio	lb/a	%	lb/a	lb/a	lb/gal	gal/a	
Stage at Harvest: Milk														
Sordan 79	12.98	7788	0.7135	27183	0.7649	20793	0.7609	15821	12.7	2302	18123	8.7505	2071	159.6
Hi Kane II	15.48	9288	0.7333	34825	0.7968	27748	0.7507	20831	15.1	3706	24537	8.8309	2778	179.4
NB 305F	16.24	9744	0.7402	37506	0.7479	28051	0.7532	21128	17.8	4576	25704	8.9213	2881	177.4
Milk Average	**14.90**	**8940**	**0.7290**	**33171**	**0.7699**	**25531**	**0.7549**	**19260**	**15.2**	**3528**	**22788**	**8.8342**	**2577**	**172.1**
Stage at Harvest: Soft Dough														
Sordan 79	15.13	9078	0.7421	35200	0.7597	26741	0.7846	20981	10.7	2514	23495	8.6835	2707	178.9
FS Average	14.96	8975	0.7323	33679	0.7673	25833	0.7624	19690	14.1	3275	22965	8.7966	2609	173.8

Whole Plant Moisture and Stalk Moisture are from oven-dried deconstructed plant sample.
Wet Stalk to Plant ratio is from deconstructed plant sample.
Stalk Juice Yield (lb/a) is Stalk Water divide by 100-Brix/100.
Stalk Juice Conversion (lb/gal) is Stalk Juice Yield (lb/a) divided by lb/gal at various Brix readings, 0.335(Brix) + 8.325 lb/gal, i.e., stalk sugar + stalk water in lb/gal.
Stalk Juice Yield (gal/a) is Stalk Juice Yield (lb/a) divided by Stalk Juice Conversion (lb/gal).
Juice Factor is Stalk Juice Yield (gal/a) divided by Silage Yield (tons/a @ 70% MC).

Table 11.-Dryland Forage and Sweet Sorghums, Silage and Potential Ethanol Production at Boot, Walsh, 2008.

Brand	Hybrid/ Variety	Stage	Silage Yield	Juice Factor	Juice Yield	Stalk Brix Reading	Potential Alcohol	Potential Ethanol Prod.	Class Juice Factor	Estimated Juice Yield	Estimated Ethanol Production
			tons/a 70% MC		gal/a	%	% v/v	gal/a		gal/a	gal/a
Forage Sorghum											
Sorghum Partners	Sordan 79	BT	4.26	338.0	1440	4.1	1.46	21.0	320.5	1365	19.9
Sorghum Partners	Hi-Kane II	BT	7.38	365.2	2695	4.4	1.64	44.2	320.5	2365	38.8
(Check)	NB 305F	BT	8.69	321.8	2796	7.8	3.68	102.9	320.5	2785	102.5
Sorghum Partners	NK300	BT	9.24	256.8	2373	8.2	3.92	93.0	320.5	2961	116.1
Forage Sorghum Average		**BT**	**7.39**	**320.5**	**2326**	**6.1**	**2.68**	**65.3**	**320.5**	**2369**	**69.3**
Sweet Sorghum											
Miss. State Univ.	Theis	BT	10.62	263.5	2798	9.4	4.64	129.8	265.8	2823	131.0
Miss. State Univ.	Dale	BT	8.85	260.8	2308	11.1	5.66	130.6	265.8	2352	133.1
Miss. State Univ.	Topper 76-6	BT	11.3	253.5	2865	10.4	5.24	150.1	265.8	3004	157.4
Miss. State Univ.	M 81-E	BT	10.35	285.3	2953	8.0	3.80	112.2	265.8	2751	104.5
Sweet Sorghum Average		**BT**	**10.28**	**265.8**	**2731**	**9.7**	**4.84**	**130.7**	**265.8**	**2732**	**131.5**
Boot Average			8.84	293.1	2529	7.9	3.76	98.0	293.2	2551	100.4

Planted: June 30 at 69.7 seeds/a x 1000.
Harvest Stage: BT, boot; FL, flowering; PM, pre-milk; EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough.
Juice Factor is the product of all the conversions from Silage Yield (tons/a @ 70% MC) to Juice Yield (gal/a).
Stalk Brix Reading is the average refractometer juice reading from the 5th and 7th internodes.
Potential Ethanol Production is Juice Yield times potential alcohol % v/v, Brix(0.6)-1.

Table 12.--Dryland Forage and Sweet Sorghums, Silage and Potential Ethanol Production at Flowering, Walsh, 2008.

Brand	Hybrid/ Variety	Stage	Silage Yield	Juice Factor	Juice Yield	Stalk Brix Reading	Potential Alcohol	Potential Ethanol Prod.	Class Juice Factor	Estimated Juice Yield	Estimated Ethanol Production
			tons/a 70% MC		gal/a	%	% v/v	gal/a		gal/a	gal/a
Forage Sorghum											
Sorghum Partners	Sordan 79	FL	7.94	293.0	2326	5.7	2.42	56.3	253.5	2013	48.7
Sorghum Partners	Hi-Kane II	FL	10.85	296.7	3219	7.8	3.68	118.5	253.5	2750	101.2
(Check)	NB 305F	FL	13.68	221.9	3036	14.1	7.46	226.5	253.5	3468	258.7
Sorghum Partners	NK300	FL	18.99	202.3	3842	11.8	6.08	233.6	253.5	4814	292.7
Forage Sorghum Average		**FL**	**12.87**	**253.5**	**3106**	**9.9**	**4.91**	**158.7**	**253.5**	**3261**	**175.3**
Sweet Sorghum											
Miss. State Univ.	Theis	FL	14.14	187.7	2654	14.2	7.52	199.6	193.2	2732	205.4
Miss. State Univ.	Dale	FL	15.03	185.9	2794	13.9	7.34	205.1	193.2	2904	213.1
Miss. State Univ.	Topper 76-6	FL	15.85	174.4	2764	16.5	8.90	246.0	193.2	3062	272.5
Miss. State Univ.	M 81-E	FL	18.47	224.7	4150	10.6	5.36	222.5	193.2	3568	191.3
Sweet Sorghum Average		**FL**	**15.87**	**193.2**	**3091**	**13.8**	**7.28**	**218.3**	**193.2**	**3067**	**220.6**
Flowering Average			14.37	223.3	3098	11.8	6.10	188.5	223.4	3164	198.0

Planted: June 30 at 69.7 seeds/a x 1000.
Harvest Stage: BT, boot; FL, flowering; PM, pre-milk; EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough.
Juice Factor is the product of all the conversions from Silage Yield (tons/a @ 70% MC) to Juice Yield (gal/a).
Stalk Brix Reading is the average refractometer juice reading from the 5th and 7th internodes.
Potential Ethanol Production is Juice Yield times potential alcohol % v/v, Brix(0.6)-1.

Table 13.-Dryland Forage and Sweet Sorghums, Silage and Potential Ethanol Production at Milk and Dough, Walsh, 2008.

Brand	Hybrid/ Variety	Stage	Silage Yield	Juice Factor	Juice Yield	Stalk Brix Reading	Potential Alcohol	Potential Ethanol Prod.	Class Juice Factor	Estimated Juice Yield	Estimated Ethanol Production
			tons/a 70% MC		gal/a	%	% v/v	gal/a		gal/a	gal/a
Forage Sorghum											
Sorghum Partners	Sordan 79	MM	12.98	159.6	2072	12.7	6.62	137.1	172.1	2234	147.9
Sorghum Partners	Hi-Kane II	MM	15.48	179.4	2777	15.1	8.06	223.8	172.1	2664	214.7
(Check)	NB 305F	MM	16.24	177.4	2881	17.8	9.68	278.9	172.1	2795	270.5
FS at Mid-Milk Average		**MM**	**14.90**	**172.1**	**2577**	**15.2**	**8.12**	**213.3**	**172.1**	**2564**	**211.1**
Forage Sorghum											
Sorghum Partners	Sordan 79	SD	15.13	178.9	2707	10.7	5.42	146.7	173.8	2630	142.5
Average			14.96	173.8	2609	14.1	7.45	196.6	172.5	2581	193.9

Planted: June 30 at 69.7 seeds/a x 1000.
Harvest Stage: BT, boot; FL, flowering; PM, pre-milk; EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough.
Juice Factor is the product of all the conversions from Silage Yield (tons/a @ 70% MC) to Juice Yield (gal/a).
Stalk Brix Reading is the average refractometer juice reading from the 5th and 7th internodes.
Potential Ethanol Production is Juice Yield times potential alcohol % v/v, Brix(0.6)-1.

Table 14.--Dryland Grain Sorghum Hybrid Performance and Ethanol Production Trial at Walsh, 2007. \1

Brand	Hybrid	Days to Emerge	50% Bloom DAP	50% Bloom GDD	50% Mature DAP	50% Mature Group	Plant Ht.	Harvest Density	Test Wt.	Grain Yield	Ethanol Yield	Total Ethanol Prod.
							in	plants/a (1000 X)	lb/bu	bu/a	gal/bu	gal/a
High Starch Hybrids												
NC+	NC+ 7C22	8	70	1879	109	ME	43	29.4	62	66	2.46	161.1
NC+	NC+ 5B89	8	65	1712	103	E	41	27.1	62	62	2.41	149.2
NC+	NC+ Y363	8	69	1845	107	ME	42	25.2	61	60	2.47	148.7
NC+	NC+ 6B50	9	80	2191	122	M	42	27.9	60	61	2.37	144.8
NC+	NC+ 5C35	7	61	1592	98	E	38	22.5	60	55	2.37	129.4
Average High Starch Hybrids		**8**	**69**	**1844**	**108**	**ME**	**41**	**26.4**	**61**	**61**	**2.42**	**146.6**
Standard Starch Hybrids												
SORGHUM PARTNERS	NK5418	8	69	1845	107	ME/M	38	26.3	61	72	2.43	175.9
ASGROW	Pulsar	9	64	1683	105	E	41	24.4	61	63	2.42	153.4
DEKALB	DKS29-28	9	62	1624	100	E	38	27.9	61	61	2.50	152.5
SORGHUM PARTNERS	NK4420	9	72	1944	112	ME	38	27.9	62	61	2.50	151.8
DEKALB	DKS37-07	9	72	1944	112	ME	41	24.4	62	62	2.35	145.0
SORGHUM PARTNERS	KS310	7	66	1743	104	E	39	29.0	61	54	2.41	130.1
SORGHUM PARTNERS	251	8	54	1401	92	E	35	30.2	60	50	2.32	116.7
Average Standard Starch Hybrids		**8**	**66**	**1741**	**105**	**E**	**39**	**27.2**	**61**	**61**	**2.42**	**146.5**
Overall Average		8	67	1784	106	ME	40	26.9	61	61	2.4	146.6
LSD 0.20										4.1		

\1 Planted: June 5; Harvested: October 29, 2007.
Yields are adjusted to 14.0% seed moisture content.
DAP: Days After Planting or maturation of seed at first freeze.
Seed Maturation: EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough; mature (DAP).
GDD: Growing Degree Days for sorghum.
Maturity Group: E, early; ME, medium early; M, medium; ML, medium late; L, late.
Ethanol Yield was derived from 7 lb grain samples that was milled, cooked, malted, fermented, and distilled.

Table 15.--Dryland Grain Sorghum Hybrid Performance and Ethanol Production Trial at Walsh, 2008. \1

Brand	Hybrid	Days to Emerge	50% Bloom DAP	50% Bloom GDD	50% Mature DAP	50% Mature Group	Plant Ht.	Harvest Density	Test Wt.	Grain Yield	Ethanol Yield	Total Ethanol Prod.
							in	plants/a (1000 X)	lb/bu	bu/a	gal/bu	gal/a
High Starch Hybrids												
NC+	NC+ 6B50	7	73	1894	118	M	42	24.6	58	75	2.54	190.0
NC+	NC+ Y363	8	72	1870	117	M/ME	44	21.7	59	73	2.41	176.4
NC+	NC+ 7C22	8	71	1854	117	M	42	24.0	60	71	2.42	172.1
NC+	NC+ 5C35	8	58	1607	106	E	37	23.8	61	71	2.31	163.5
NC+	NC+ 5B89	8	67	1806	115	ME	39	22.5	58	69	2.47	171.4
Average High Starch Hybrids		**8**	**68**	**1806**	**115**	**ME**	**41**	**23.3**	**59**	**72**	**2.43**	**174.7**
Standard Starch Hybrids												
SORGHUM PARTNERS	NK5418	7	70	1840	117	M	40	23.5	59	77	2.63	202.0
ASGROW	Pulsar	7	62	1698	112	E	44	26.9	60	75	2.43	181.0
DEKALB	DKS37-07	8	69	1830	115	ME	42	25.4	59	75	2.55	190.0
DEKALB	DKS29-28	8	61	1678	113	E	33	24.2	60	65	2.39	156.3
SORGHUM PARTNERS	KS310	8	64	1747	114	ME/E	42	23.1	59	63	2.36	149.2
SORGHUM PARTNERS	251	8	55	1514	102	E	33	23.7	60	49	2.28	111.7
Average Standard Starch Hybrids		**8**	**64**	**1718**	**112**	**E**	**39**	**24.5**	**60**	**67**	**2.44**	**165.0**
Average		8	66	1758	113	ME	40	23.9	59	69	2.44	169.4
LSD 0.20										6.6		

\1 Planted: June 10; Harvested: November 25, 2008.
Yields are corrected to 14.0% seed moisture content.
DAP: Days After Planting or maturation of seed at first freeze.
Seed Maturation: EM, early milk; MM, mid milk; LM, late milk; ED, early dough; SD, soft dough; HD, hard dough; mature (DAP).
GDD: Growing Degree Days for sorghum.
Maturity Group: E, early; ME, medium early; M, medium; ML, medium late; L, late.
This study was pre-irrigated with about 8 in./a of furrow irrigation to ensure stand establishment.
Ethanol Yield was derived from 7 lb grain samples that was milled, cooked, malted, fermented, and distilled.

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Limited Sprinkler Irrigation Grain Sorghum Study at Walsh, 2009

COOPERATORS: Plainsman Agri-Search Foundation; K. Larson, D. Thompson, D. Harn, C. Thompson, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify grain sorghum hybrids that produce highest yields given sprinkler limited irrigation.

RESULTS: The highest yielding hybrid, Mycogen 697, produced 96 bu/a and had the highest test weight of 61 lb/bu. The lowest yielding hybrid, Triumph TRX85002, produced 66 bu/a and had the lowest test weight of 53 lb/bu.

PLOT: Four rows with 30" row spacing, at least 600' long. SEEDING DENSITY: 80,000 seeds/a. PLANTED: June 1. HARVESTED: November 9.

IRRIGATION: Six sprinkler rotations applied 7.5 acre-in/a of total water.

PEST CONTROL: Preemergence Herbicides: Glyphosate 24 oz/a, 2,4-D 0.5 lb/a; Post Herbicides: Atrazine 1.0 lb/a, Banvel 4 oz/a, COC 1.0 qt/a. CULTIVATION: Once. INSECTICIDE: None.

FIELD HISTORY: Last Crop: Corn. FIELD PREPARATION: Disc.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------No. of Days--------		
June	3.71	663	14	1	30
July	7.92	824	19	5	61
August	1.75	712	15	0	92
September	2.50	467	5	0	122
October	0.00	28	1	0	124
Total	15.88	2694	54	6	124

\1 Growing season from June 1 (planting) to October 2 (first freeze, 30 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

COMMENTS: Planted in good soil moisture. Weed control was good. Above normal precipitation for the growing season with a very wet July. Even though the season was cooler than normal and the first freeze was 10 days earlier than average, only two hybrids failed to fully mature. Grain yields were good.

SOIL: Silty Clay Loam for 0-8" and Silty Clay Loam 8"-24" depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8"	7.9	0.6	1.7	14	1.2	366	0.5	3.0
8"-24"				13				
Comment	Alka	Vlo	Hi	Hi	VLo	VHi	Lo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	40	2	0
Applied	100	20	0.3	0

Yield Goal: 90 bu/a.
Actual Yield: 83 bu/a.

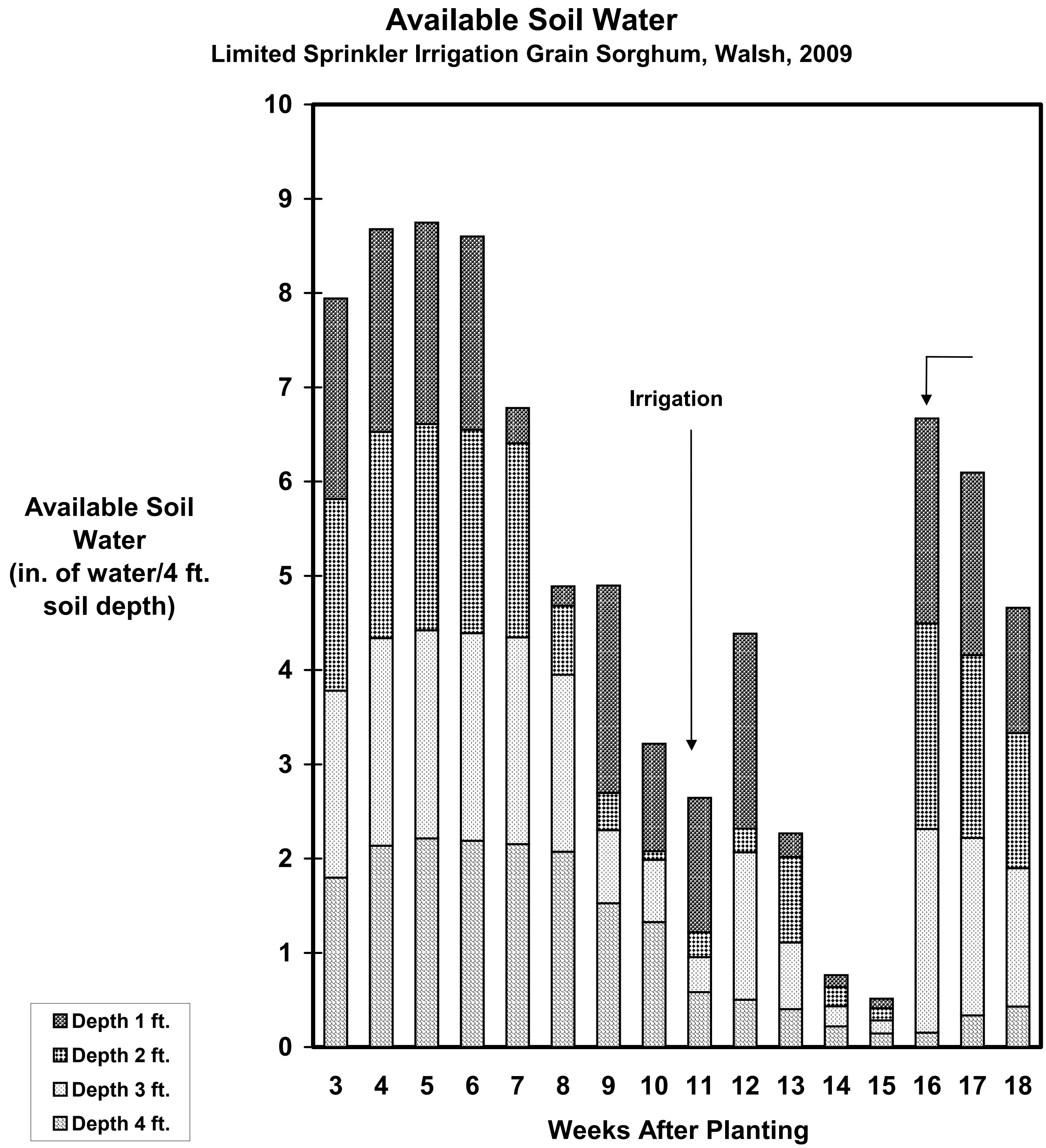

Fig. . Available soil water in limited sprinkler irrigation grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 15.88 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table .Limited Sprinkler Irrigation Grain Sorghum, Plainsman Research Center, Walsh, 2009.

Brand	Hybrid	Plant Density	50% Flowering Date	50% Maturity Date	Plant Height	Seed Moisture Content	Test Weight	Grain Yield
		plants/ac (1000X)			%	%	lb/bu	bu/ac
MYCOGEN	697	47.2	8/16	10/2	44	12.1	61	96
NC+	NC+ 64-09	42.8	8/15	10/2	44	11.0	59	92
TRIUMPH	TR 452	46.8	8/13	9/24	45	12.9	59	90
NC+	NC+ 6B50	52.0	8/16	10/2	48	10.6	59	89
GOLDEN HARVEST	H-390W	46.0	8/17	10/2	44	12.9	58	89
MYCOGEN	627	44.4	8/14	9/25	46	12.8	59	87
NC+	NC+ 62-09	51.6	8/15	10/1	48	10.6	59	85
PIONEER	86G32	54.4	8/10	9/21	44	12.8	60	83
NC+	NC+ 63-09	46.8	8/19	HD	45	12.8	56	82
TRIUMPH	TR 448	46.4	8/14	10/1	43	12.9	60	80
GARST	5750	53.6	8/14	9/30	43	13.0	59	79
GARST	5631Y	41.6	8/15	10/1	43	11.2	59	76
TRIUMPH	TRX95003	47.2	8/17	10/2	50	13.1	58	75
TRIUMPH	TRX85002	43.6	8/25	SD	49	12.6	53	66
Average		47.5	8/15	10/1	45	12.2	59	83
LSD 0.20								3.0

Planted: June 1; Harvested: November 9, 2009.
50% Flowering Date: minimum date on which a hybrid flowers on half of its population.
50% Maturity Date or maturation of seed at first freeze (30 F, October 2)
Seed Maturation: LM, late milk; ED, early dough, SD, soft dough; HD, hard dough; mature (date).
The limited sprinkler irrigation grain sorghum received 7.5 acre-in of applied water.
Yields are adjusted to 14.0% seed moisture content.

Limited Sprinkler Irrigation Corn Study at Walsh, 2009

COOPERATORS: Plainsman Agri-Search Foundation; K. Larson, D. Thompson, D. Harn, C. Thompson, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify corn hybrids that produce highest yields given sprinkler limited irrigation.

RESULTS: Of the 17 hybrids tested, NC+ 5436VT3 was the highest yielding hybrid with 198 bu/a. For this limited irrigation trial, we applied 15 in./a of water.

PLOT: Four rows with 30" row spacing, at least 600' long. SEEDING DENSITY: 27,000 seeds/a. PLANTED: May 5. HARVESTED: November 30.

IRRIGATION: Twelve sprinkler rotations applied 15.0 a-in/a of total water.

PEST CONTROL: Pre Herbicides: Balance 1.75 oz/a, Atrazine 1.0 lb/a, Glystar Plus 24 oz/a, LoVol 0.5 lb/a; Post Herbicides: Roundup WeatherMax 24 oz/a, Banvel 6 oz/a. CULTIVATION: None. INSECTICIDE: None.

FIELD HISTORY: Last Crop: Grain Sorghum. FIELD PREPARATION: Disc.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------No. of Days--------		
May	0.67	399	1	0	26
June	3.71	663	14	1	56
July	7.92	824	19	5	87
August	1.75	712	15	0	118
September	2.50	467	5	0	148
October	0.00	28	1	0	150
Total	16.55	3093	55	6	150

\1 Growing season from May 5 (planting) to October 2 (first freeze, 30 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

COMMENTS: Planted in good soil moisture. Weed control was very good. Above normal precipitation for the growing season with a very wet July. The nonresistant corn borer hybrid had relatively low amounts of stock holes and lodging from second-generation corn borer larvae. Grain yields were very good.

SOIL: Silty Clay Loam for 0-8" and Silty Clay Loam 8"-24" depths from soil analysis.

Summary: Soil Analysis from Sprinkler Site.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------		ppm	----------------	
0-8"	7.8	0.6	2.0	15	1.2	359	0.4	2.8
8"-24"				13				
Comment	Alka	VLo	Hi	Hi	VLo	VHi	VLo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization for Sprinkler Site.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	52	40	2	0
Applied	150	20	0.4	0

Yield Goal: 135 bu/a.
Actual Yield: 1185 bu/a.

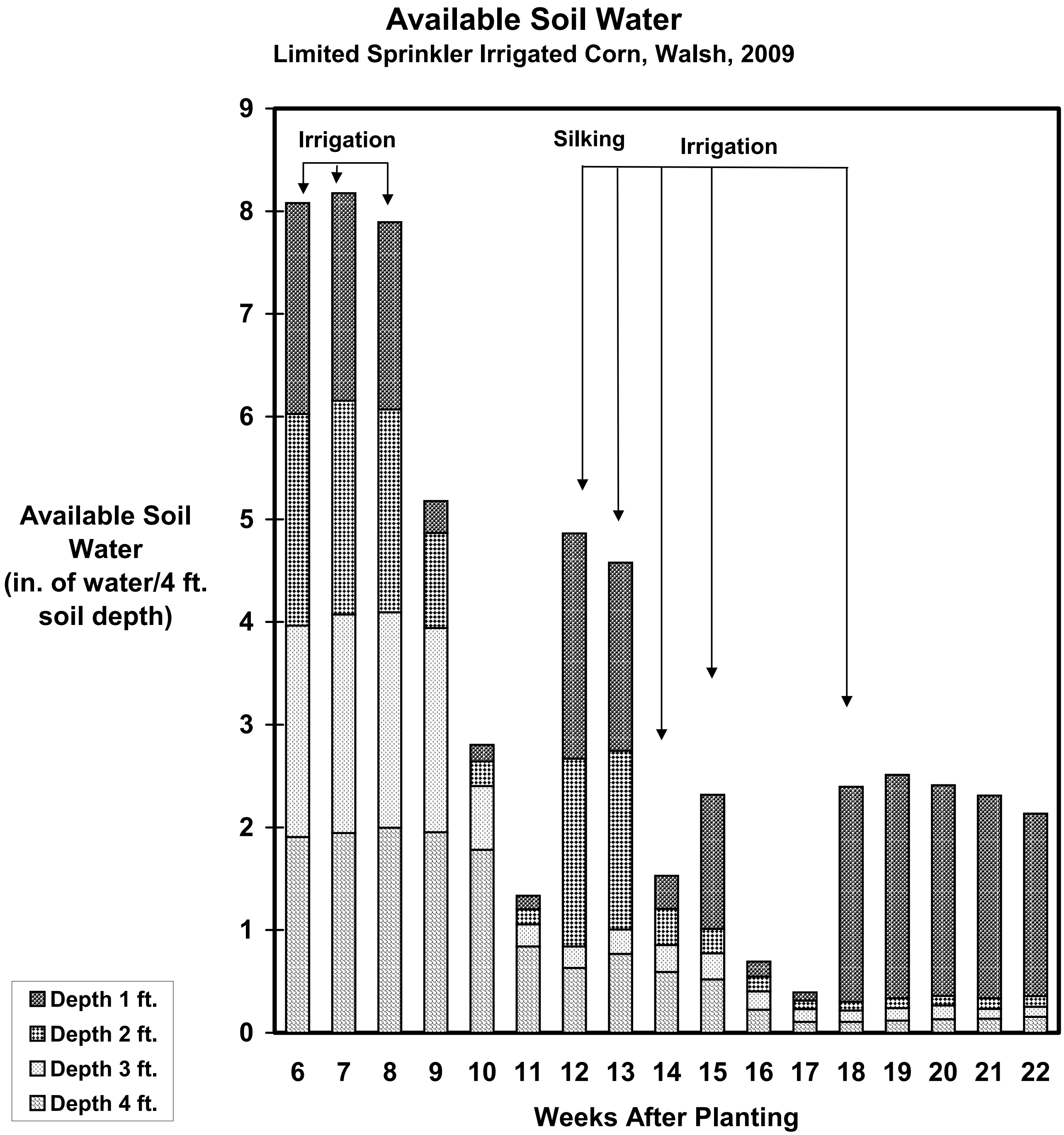

Fig. . Available soil water in limited sprinkler irrigation corn at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 16.55 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table .Limited Sprinkler Irrigation Corn, Plainsman Research Center, 2009.

Firm	Hybrid	50% Silking Date	Plant Density	Seed Moisture	Test Weight	Grain Yield
			plants/a (X 1000)	%	lb/bu	bu/a
NC+ HYBRIDS	NC+ 5436VT3	23-Jul	26.0	15.1	59	198
GARST	83E90-3000GT	25-Jul	26.6	15.3	58	197
TRIUMPH	1420V	25-Jul	26.4	15.4	58	196
MYCOGEN	2T777 (Non Bt)	26-Jul	25.2	15.0	59	191
PIONEER	P1508HR	28-Jul	26.8	15.3	61	188
GARST	83T94 GT/CB/LL	25-Jul	25.0	15.2	57	188
TRIUMPH	7514X	26-Jul	26.4	15.1	59	187
NC+ HYBRIDS	NC+ 4252VT3	25-Jul	26.6	15.0	59	184
MYCOGEN	2V732	26-Jul	26.4	15.3	59	184
MYCOGEN	2T832	26-Jul	23.8	15.2	57	183
PIONEER	33D49	28-Jul	25.4	14.9	60	183
MYCOGEN	2T826	27-Jul	25.0	15.3	58	182
TRIUMPH	1121V	24-Jul	27.0	15.3	60	181
NC+ HYBRIDS	NC+ 5453VT3	26-Jul	24.6	15.1	60	178
GARST	85Z64 GT/CB/LL	22-Jul	24.6	15.0	58	177
NC+ HYBRIDS	210-57VT3	24-Jul	25.6	14.9	59	176
TRIUMPH	1305X	22-Jul	24.8	15.1	58	176
Average		25-Jul	25.7	15.1	59	185
LSD 0.20						4.1

Planted: May 5; Harvested: November 30, 2009.
Grain Yield adjusted to 15.5% moisture content.
Twelve sprinkler rotations applied a total of 15.0 acre-in./acre of water.

Corn Borer Resistant and Nonresistant Hybrid Comparisons, Walsh, 2009

K. Larson, D. Thompson, D. Harn, C. Thompson

PURPOSE: To evaluate corn borer resistant hybrids (Bt gene insertion) and nonresistant hybrids under limited sprinkler irrigation.

RESULTS: Only the nonresistant corn borer hybrids displayed any first generation corn borer damage and this shot hole damage was very minor. There was more second-generation corn borer damage this year than last year, but the damage this year was still less than recent years. Compared to damage recorded in last year, the nonresistant corn borer hybrid had slightly more stock holes and lodging damage caused by the second-generation corn borer larvae. Grain yields were very good.

DISCUSSION: All 16 Bt hybrids tested showed excellent resistance to corn borer compared to the nonresistant hybrid. The nonresistant corn borer hybrid had stock holes on 23% of its plants and 8% of plants lodged due to corn borer damage This level of corn borer lodging is higher than last year, but it is less than the damage level record since Bt corn hybrids became widely accepted. The low level of corn borer damage may be attributable to our region's extensive use of corn borer resistant hybrids. Even with a couple of years of low corn borer levels, we still advocate the use of corn borer resistant hybrids. Nonetheless, if these low infestation levels continue, it may be economical to replace some acreage with less expensive nonresistant corn borer hybrids. Growers can monitor the corn borer infestation levels in their refuges to indicate if switching is warranted. Corn borer resistant Bt hybrids continue to be a very effective tool against corn borer damage. Therefore, to keep Bt hybrids effective in controlling corn borer, always remember to plant nonresistant hybrids as a mating refuge to help delay corn borer resistance to the Bt events.

We define limited sprinkler corn as receiving 10 inches or less of irrigation above normal precipitation. This year we applied 15 inches of irrigation. Even though the growing season was wet, there was insufficient precipitation during the winter and spring to fill the soil water profile. The extra 5 inches of irrigation was used to fill the soil water profile.

Table .Limited Sprinkler Irrigated Corn, Corn Borer Ratings, Plainsman Research Center, 2009.

Firm	Hybrid	50% Silking Date	Plant Density	1st Gen Shot Holes	2nd Gen Stock Holes	2nd Gen Plant Lodging	Test Weight	Grain Yield
			plants/a (X 1000)				lb/bu	bu/a
NC+ HYBRIDS	NC+ 5436VT3	23-Jul	26.0	0	0	0	59	198
GARST	83E90-3000GT	25-Jul	26.6	0	0	0	58	197
TRIUMPH	1420V	25-Jul	26.4	0	0	0	58	196
MYCOGEN	2T777 (Non Bt)	26-Jul	25.2	3	23	8	59	191
PIONEER	P1508HR	28-Jul	26.8	0	0	0	61	188
GARST	83T94 GT/CB/LL	25-Jul	25.0	0	0	0	57	188
TRIUMPH	7514X	26-Jul	26.4	0	0	0	59	187
NC+ HYBRIDS	NC+ 4252VT3	25-Jul	26.6	0	0	0	59	184
MYCOGEN	2V732	26-Jul	26.4	0	0	0	59	184
MYCOGEN	2T832	26-Jul	23.8	0	0	0	57	183
PIONEER	33D49	28-Jul	25.4	0	0	0	60	183
MYCOGEN	2T826	27-Jul	25.0	0	0	0	58	182
TRIUMPH	1121V	24-Jul	27.0	0	0	0	60	181
NC+ HYBRIDS	NC+ 5453VT3	26-Jul	24.6	0	0	0	60	178
GARST	85Z64 GT/CB/LL	22-Jul	24.6	0	0	0	58	177
NC+ HYBRIDS	210-57VT3	24-Jul	25.6	0	0	0	59	176
TRIUMPH	1305X	22-Jul	24.8	0	3	0	58	176
Average		25-Jul	25.7	0	2	0	59	185
LSD 0.05				1.8	5.6	1.8		4.1

Planted: May 5; Harvested: November 30, 2009.
Grain Yield adjusted to 15.5% moisture content.
Twelve sprinkler rotations applied a total of 15.0 acre-in./acre of water.

Long-Term N Effects on Irrigated Sunflower-Corn Rotation, Walsh, 2009

K. Larson, D. Thompson, D. Harn, and C. Thompson

Purpose: To study the long-term N fertilizer effects on irrigated Sunflower-Corn and Corn-Corn (continuous corn) rotations where N rate are applied to the same treatment site for multiple years.

Materials and Methods: We planted corn, Mycogen 2T832, on May 6 at 27,000 seeds/a, and sunflower, Pioneer 63N82 on June 24 at 26,000 seeds/a. For our N treatments, we streamed liquid N (32-0-0) at 0, 50, or 100 lb N/a with two replications. We seedrow applied 20 lb P_2O_5/A to the corn and sunflowers. In addition to the seedrow applied P, the corn received 0.38 lb Zn/a. For weed control, we applied pre-emergence Glystar Plus 24 oz/a and 0.5 lb/a of 2,4-D to both the corn and sunflower plots. The corn also received pre-emergence Balance 1.75 oz/a and Atrazine 1.0 lb/a. For Postemergence weed control in the corn, we applied two applications of Roundup Weather Max at 24 oz/a. For weed control in the sunflower, we applied pre-emergence Spartan 2 oz/a and Prowl H2O 40 oz/a. The corn received approximately 14 in./a of drip irrigation and the sunflower received approximately 10 in./a of drip irrigation (we used approximations because we had well problems). Other than herbicides, no other pesticides were applied to the corn, but we did apply Warrior on the sunflowers to control head moth. We harvested two replications of the 20 ft. by 650 ft. plots on December 1 for corn and November 11 for sunflower with a self-propelled combine and weighed them in a digital weigh cart. Yields were adjusted to 15.5% for corn and 10% for sunflower.

Results and Discussion: The corn in Sunflower-Corn and continuous corn rotations responded differently to increasing N rates: the Sunflower-Corn rotation did not respond to N, and the continuous corn rotation increased linearly with increasing N rates. If the corn in the Sunflower-Corn rotation continues to have no response to increasing N, this would indicate that relatively low amounts of applied N are needed for high corn yields following sunflowers. Continuous corn required high rates of N for high grain yields. High rates of N for high yields would be the acceptable practice for corn production. Therefore, the increased yield with increased N for continuous corn is not surprising, but the lack of N response of corn following sunflower is surprising.

The response of the sunflower to increasing N rates was also quite flat. There were less than 100 lb/a differences between the seed yield responses to N rates. Like previous years, the 150 lb N/a rate produces the lowest yield. After reviewing the soil test recommendation, it is not surprising that the 100 lb and 200 lb N/a rates produced similarly high of corn and sunflower yields in the Sunflower-Corn rotation. The recommended N fertilizer rates for our yield goals were 50 lb N/a for sunflower and 0 lb/a for corn. Our yield goal for the corn was 175 bu/a, our actual average grain yield was 176 bu/a, and the yield goal for the sunflowers was 2500 lb/a, our actual average seed yield was 2154 lb/a or 941 lb/a oil yield. We did not observe the typical percent oil decrease with increasing N. The oil percentages were also quite flat: 43.4, 43.9, and 43.7, respectively for 100, 150, and 200 lb N/a.

Table .-Soil Analysis.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				ppm						
0-8”	7.7	0.7	2.0	27	2.1	554	0.5	2.6	9.7	3.8
8-24”				25						

This is the fourth year of this long-term N on Sunflower-Corn rotation study. We started this study because of 1) the lack of N response for dryland sunflower in our long-term N on Wheat-Sunflower-Fallow study, 2) the role of N in reducing oil yield, and 3) reports from growers that their irrigated corn following sunflower often produced their highest yields. This year, the difference in average corn yield between the Sunflower-Corn and continuous corn rotations was 18 bu/a, which confirms reports of growers of higher corn yields following sunflower. Under dryland conditions, crop yields are often reduced following sunflower in the rotation. The yield reduction in the crop following sunflower is due to the deep and thorough extraction of the available water in the soil profile, leaving the subsequent crop with little soil water profile base. With irrigation, the dry soil profile left by sunflower is not a detriment since the soil profile can be refilled by irrigation. Moreover, we speculate that the reason irrigated corn yields well following sunflower is that the deep water extraction of sunflower loosens the soil and provides better root penetration by the corn.

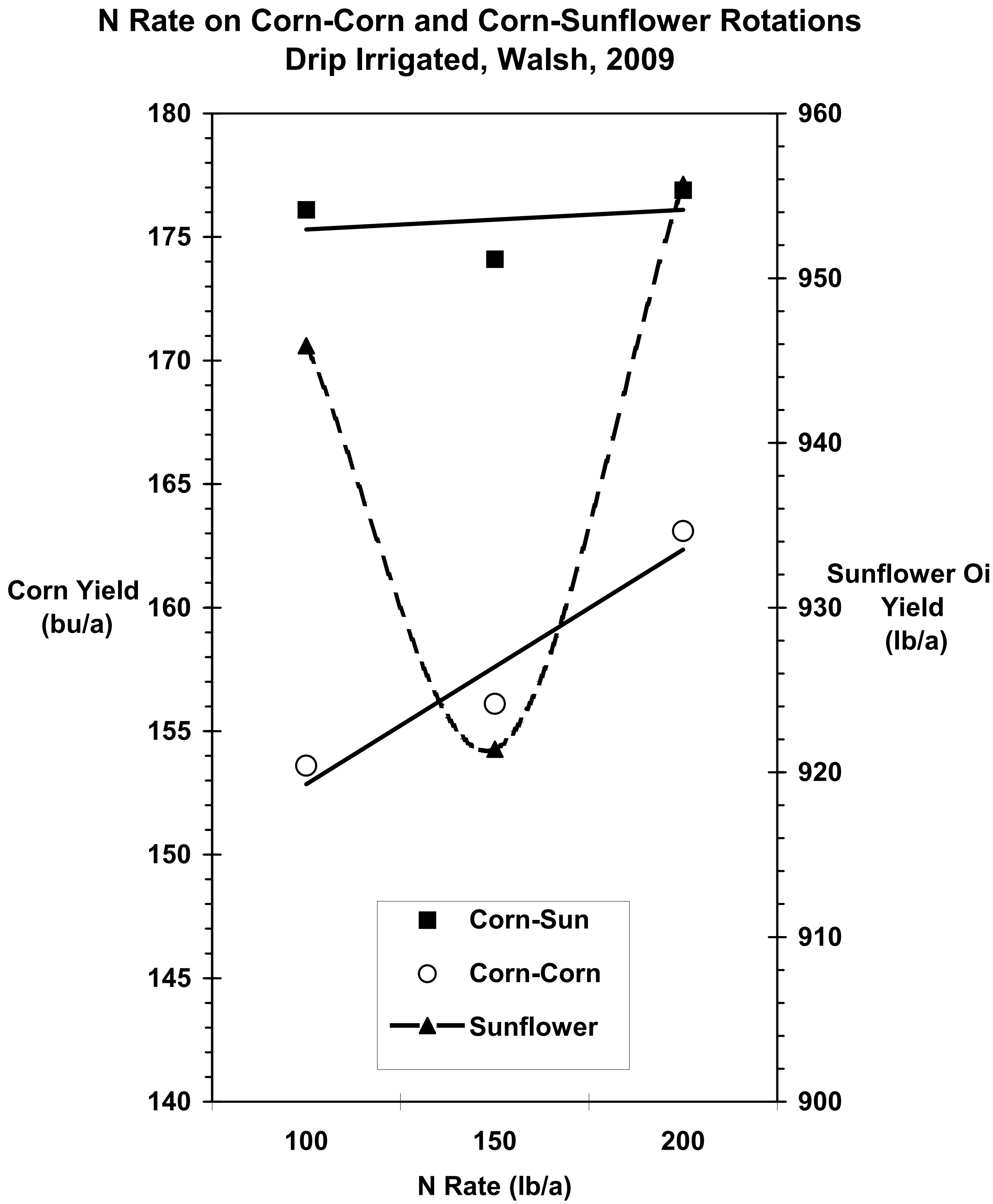

Fig. . N rate on drip irrigated sunflower and corn in Sunflower-Corn rotations at Walsh. The N rates were 100, 150, and 200 lb N/a as 32-0-0. The sunflower hybrid was PIONEER 63N82 planted at 26,000 seeds/a. The corn hybrid was MYCOGEN 2T832 planted at 27,000 seeds/a.

Long-Term N Effects on Wheat-Sunflower-Fallow Rotation, Walsh, 2009

K. Larson, D. Thompson, D. Harn, and C. Thompson

Purpose: To study the long-term N fertilizer effects on a wheat-sunflower-fallow rotation where N is applied to the same treatment plots for multiple years.

Materials and Methods: We planted wheat, Hatcher, at 50 lb seed/a on October 1, 2008, and sunflower on June 22, 2009 at 20,000 seeds/a using MYCOGEN 8N419CL. We banded liquid N (32-0-0) at 0, 30, 60, and 90 lb N/a to the treatment plots with two replications to both N and N residual sides on April 14, 2009 for wheat, and no N was applied to the sunflower this season (the sunflower N response was to residual N applied to the wheat the previous season). We seedrow applied 5 gal/a of 10-34-0 (20 lb P_2O_5/a) at planting to both the wheat and the sunflowers. For weed control in the wheat, we applied pre-emergence Glystar Plus 24 oz/a and 2,4-D 0.5 lb/a and postemergence Express, 0.33 oz/a and 2,4-D, 0.38 lb/a. For weed control in the sunflower, we applied pre-emergence Glystar Plus 24 oz/a, Spartan 2 oz/a, and Prowl H2O 40 oz/a. We harvested two replications of the 20 ft. by 1100 ft. plots on July 1 for wheat and November 12 for sunflower with a self-propelled combine and weighed them in a digital weigh cart. Yields were adjusted to 12.0% for wheat and 10% for sunflower.

Results: Wheat yields did not respond to increasing N rates. There was less than one bushel/acre difference between any of the N rates. Wheat yields were good, averaging 32 bu/a. Sunflower yields declined with increasing residual N rates, although the linear decrease was not significant. Sunflower yields were good, ranging from 1057 lb/a to 1244 lb/a. The percent oil in the sunflower seeds decreased with increasing N rates, although this, too, was not significant. Both wheat and sunflower did not respond to N rates.

Discussion: This is the eighth harvest year of this long-term N on wheat-sunflower-fallow rotation study. We started this study to test reports of no yield response from applied N on dryland sunflower (Vigil and Bowman, 1998).

This year, the wheat did not respond to applied N. Only one time in eight years had the wheat respond to applied N. Since the wheat did not respond to applied N, applying N could not be justified. The non-response of wheat yields to increasing N rates for seven out of eight years can be explained by sufficient residual N for the first year and low to average yields for the subsequent years. Last year, there was sufficient winter moisture to produce very good wheat yields (over 50 bu/a), and last year the wheat responded to N rates. Although, this positive response to applied N was not economical. Generally, however, moisture has been the primary yield-limiting factor for this study, not N.

This year the sunflower yields were good; however, sunflower yields did not respond to residual N (this year we forgot to apply N on the sunflowers). The 0 N treatment, which has not received any applied N for eight harvest years, produced the highest seed yield and had the highest seed oil content of any of the N treatments.

With the exception of last year, we have reported no wheat yield response to N rates since establishing this wheat-sunflower-fallow rotation study. For seven out of eight years, wheat yields in this rotation were very low to average, 6 to 32 bu/a. The low to average wheat yields can be attributed to the lack of moisture remaining after sunflower extracted all available soil water and little soil water replenishment due to dry conditions during fallow. For wheat production in this wheat-sunflower-fallow rotation, moisture was probably the limiting factor, not N. Last year, when the wheat did respond to applied N, the yield response was insufficient to justify the N cost.

This year, sunflower yields did not respond to residual N. Most years, sunflower yields increased with increasing N rates; however the yield response failed to offset the cost of the N fertilizer. The no N fertilizer treatment produced the highest income every year of sunflower production (there was no sunflower crop in 2002 and 2008 because of drought). This year, the 0 N treatment produced the highest sunflower yield. This lack of N response suggests that N fertilizer is not needed for dryland sunflower production if the expected yield is 1200 lb/a or less.

Seed oil content tends to decrease with increasing N rates. This year there was a non-significant decrease in oil content with increasing N rates: 42.2%, 39.6%, 41.5%, and 39.4% for 0, 30, 60, and 90 lb N/a, respectively. Generally in previous years, we observed no response or a decline in oil content with increasing N rates. This negative correlation of oil content with N rate has been previously reported (Vigil and Bowman, 1998).

Literature Cited

Vigil, M.F., R.A. Bowman. 1998. Nitrogen response and residue management of sunflowers in a dryland rotation. 1998 Annual Report, Central Great Plains Research Station. ARS, USDA.

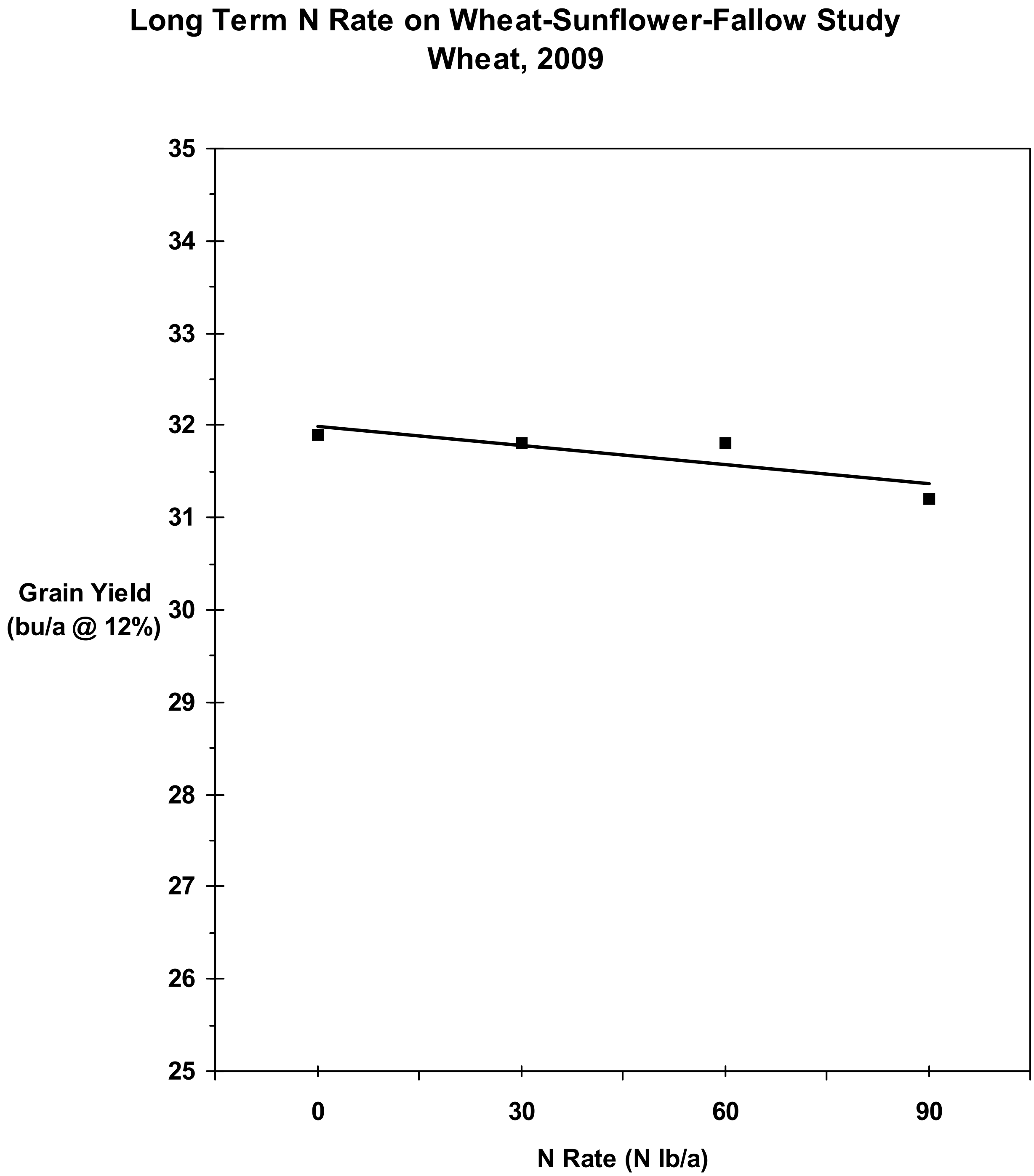

Fig. . N rate on dryland wheat in Wheat-Sunflower-Fallow rotation at Walsh. The N rates were 0, 30, 60, and 90 lb N/a as 32-0-0. The wheat variety was Hatcher sown at 50 lb/a.

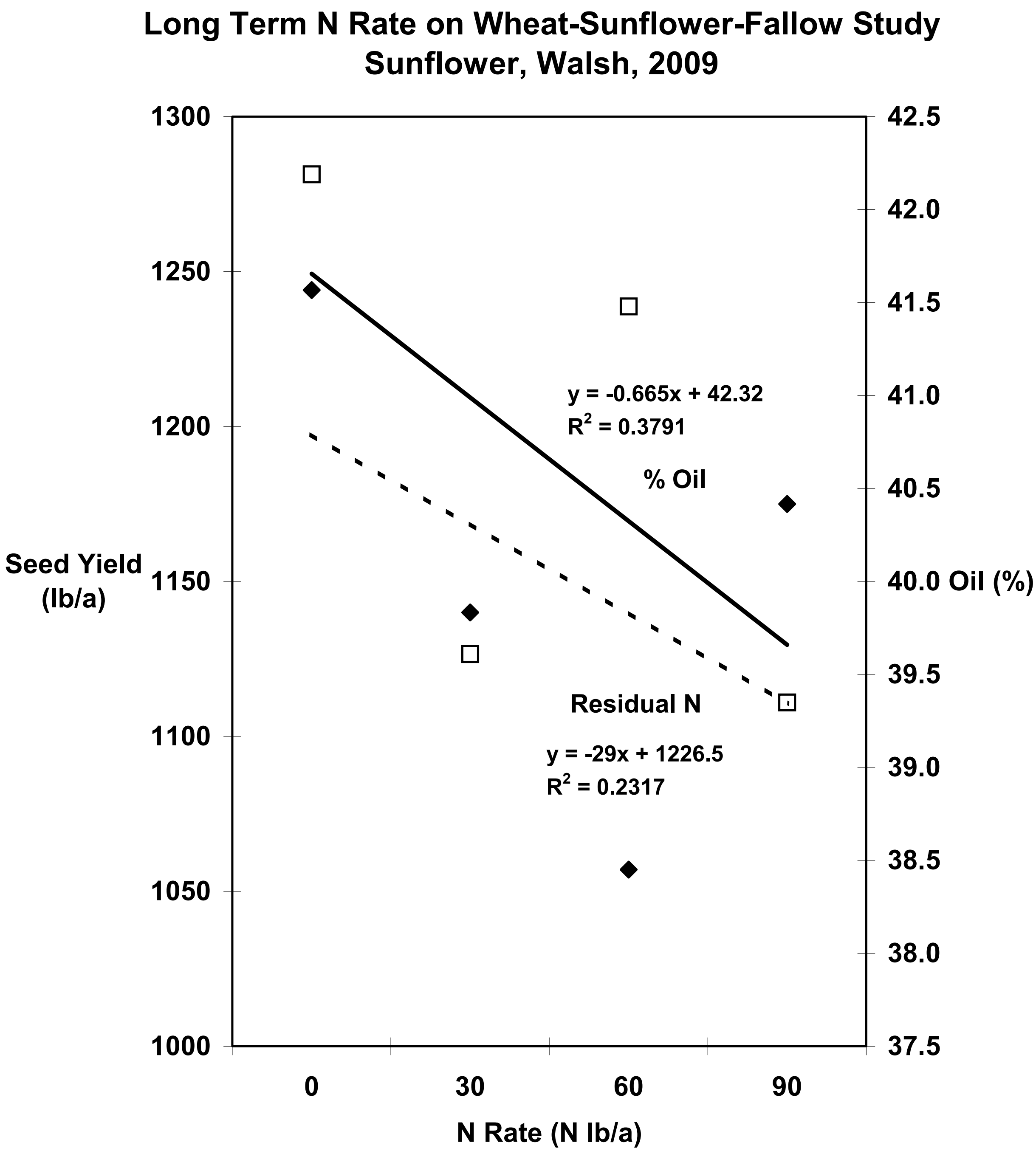

Fig. . N rate on dryland sunflower in Wheat-Sunflower-Fallow rotation at Walsh. The Residual N rates were 0, 30, 60, and 90 lb N/a as 32-0-0 applied to the wheat the previous season. The sunflower hybrid was MYCOGEN 8N419CL at 20,000 seeds/a.

Dryland Crop Rotation Study

Kevin Larson and Dennis Thompson

This is the fourth cropping year for our dryland rotation study. We established these rotations because of results from our dryland rotation sequencing study and growers' desire to include winter wheat in the rotations. The dryland rotation sequencing study was designed for spring crops and the inclusion of winter wheat with its fall planting and early summer harvesting times would not fit into the design pattern of the sequencing study. To include winter wheat into a dryland rotation study, we began a new dryland rotation study with these three rotations in 2005: 1) Wheat-Sorghum-Fallow, 2) Wheat-Sunflower-Fallow, and 3) Sorghum-Millet. In 2006, we added a fourth rotation, Millet/Wheat-Fallow, to this rotation study.

Materials and Methods

This is our fourth year in testing the following rotations: Wheat-Grain Sorghum-Fallow (W-S-F), Wheat-Sunflower-Fallow (W-Sun-F), and Sorghum-Millet (S-M). We added a fourth rotation of Millet/Wheat-Fallow (M/W-F) in 2006. In 2008, no crops were harvested because of drought. We planted wheat, Hatcher, at 50 lb/a on October 1, 2008; Proso millet, Huntsman, at 20 lb/a on June 25, 2009; grain sorghum, Mycogen 627, at 32,500 seeds/a on June 17, 2009; and sunflower, Mycogen 8H419CL, at 20,000 seeds/a on June 23, 2009. We applied 50 lb N/a to the study site. Before planting we sprayed two applications of Glystar Plus at 24 oz/a and LoVol at 0.5 lb/a. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: wheat, Express 0.33 oz/a, LoVol 0.38 lb/a, and Penetrant II 8 oz/a; millet, Banvel 4 oz/a and amine 10 oz/a; grain sorghum, Atrazine 1.0 lb/a, Banvel 4 oz/a, and COC 32 oz/a; sunflower, Prowl H2O 40 oz/a and Spartan 2 oz/a; and fallow, Glystar Plus 20 oz/a, Banvel 4 oz/a and LoVol 0.5 lb/a two times. We harvested the crops with a self-propelled combine equipped with a digital scale: wheat, July 2; millet, September 10; grain sorghum, November 4; and sunflower was not harvested because of chemical damage. We recorded cost of production and yields in order to determine rotation revenues.

Results and Discussion

The M/W-F rotation produced the highest wheat and millet production (wheat, 45 bu/a; millet 35 bu/a), and the highest annual rotation variable net income, $143.26/a, for 2009. The W-S-F rotation had the highest total rotational crop production with 5716 lb/a, but because it had a less valuable crop (grain sorghum) in its rotation, it was only third in annualized variable net income. The S-M rotation was second highest in annual rotation variable net income with $141.76/a. In both 2007 and 2009, the W-Sun-F rotation produced the least variable net income because the sunflower crop failed. When we project these rotations over a six-year cycle by using 2006, 2007, and 2009 crop incomes for the initial three-year base, the M/W-F rotation provides the highest total variable net income of $862,61/a. The reason M/W-F has a higher total income for a projected six-year period compared to W-S-F is because M/W-F has six crops (three complete rotational cycles) and W-S-F has only four crops (two complete rotational cycles) in six years. Less fallow, more crops, more income.

We are still in the establishment phase with these rotations and we already have had crop failures, therefore rotational affects are, at best, difficult to generalize and quantify. Abundant winter moisture produced good yields for most crops in 2007 despite the very dry summer conditions. Sunflower yields were low in 2007. Because of chemical damage, we failed to get sunflower stands in 2006 and 2009. Winter wheat has performed better than the spring crops in both yield and income. This is primarily due to more favorable moisture during the wheat growing seasons. The higher wheat yield suggests that having a winter grain in the rotation spreads the cropping risk and increases crop rotation revenue.

Table .-Dryland Crop Rotation Study, Crop Production, 2009.

Crop Production						
	--------------------------2009 Crop---------------------------					2009 Total Rotation
Rotation	Wheat	Grain Sorghum	Millet	Sunflower	Fallow	Production
	-------------------------------------lb/a----------------------------------					
W-S-F	2502	3214			0	5716
W-Sun-F	2346			0	0	2346
M/W-F	2706		1937			4643
S-M		3461	1572			5033
Average	2518	3338	1755	0	0	4435
LSD 0.20	377.4	369.6	870.2			

There was no sunflower crop because of chemical damage.

Table .-Dryland Crop Rotation Study, Walsh, 2009.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
		--------------------------------------$/a--					
<u>Wheat</u>	50 lb	6.67	15.33	42.0 bu	4.75/bu	199.34	177.34
M/W-F				45.1	4.75	214.23	192.23
W-Sun-F				39.1	4.75	185.73	163.73
W-S-F				41.7	4.75	198.08	176.08
<u>Millet</u>	20 lb	2.86	7.98	31.4 bu	3.92/bu	122.89	112.05
S-M				28.1	3.92	110.15	99.31
M/W-F				34.6	3.92	135.63	124.79
<u>Grain Sorghum</u>	32,500 seeds	3.83	12.81	59.6 bu	3.25/bu	193.70	177.06
S-M				61.8	3.25	200.85	184.21
W-S-F				57.4	3.25	186.55	169.91
<u>Sunflower</u>	20,000 seeds	24.20	25.97	0 lb	0.135/lb	0.00	-50.17
W-Sun-F				0	0.135	0.00	-50.17
Fallow	---	---	30.50	---	---	0.00	-30.50
Average			18.52			103.19	77.16

Planted: Grain Sorghum Mycogen 627 at 32,500 on June 17; Millet, Huntsman at 20 lb/a on June 25; and Sunflower Mycogen 8H419CL at 20,000 seeds/a on June 23; Wheat, Hatcher at 50 lb/a on October 1, 2008.
Harvested: Millet, September 10; Sunflower, not harvested; and Grain Sorghum, November 4; Wheat, July 2, 2009.
Weed control cost is herbicide cost and $5.50/a application cost for each application.

Table .-Dryland Crop Rotation Study, Variable Net Income, 2009.

Rotation	Wheat	Grain Sorghum	Millet	Sunflower	Fallow	2009 Total Crop Net Income	Annual Rotation Variable Net Income
	--------------------------2009 Crop--------------------------						
	---$/a---						
W-S-F	176.08	169.91			-30.50	315.49	105.16
M/W-F	192.23		124.79		-30.50	286.52	143.26
S-M		184.21	99.31			283.52	141.76
W-Sun-F	163.73			-50.17	-30.50	83.06	27.69
Average	177.35	177.06	112.05	-50.17	-30.50	242.15	104.47

Variable Net Income is gross income minus seed cost and weed control cost.
The sunflowers were not harvested because of chemical damage.

Dryland Crop Rotation Study, Variable Net Income Summary, 2006, 2007 & 2009.

		Variable Net Income ------------2006, 2007, 2009 Crops-------------					3-Year Total Rotation Variable Net Income	6-Year Total Net Income Rotation Projection
Rotation	Year	Wheat	Grain Sorghum	Millet	Sunflower	Fallow		
		----------------------------------$/a--						
W-S-F	Avg	169.42	115.80			-22.98	262.23	524.47
	2006	76.97	51.28			-18.24	110.01	220.02
	2007	255.20	126.20			-20.20	361.20	722.40
	2009	176.08	169.91			-30.50	315.49	630.98
M/W-F	Avg	217.34		93.18		-22.98	287.54	862.61
	2006			61.57		-18.24	43.33	129.99
	2007	242.44				-20.20	222.24	666.72
	2009	192.23		124.79		-30.50	286.52	859.56
S-M	Avg		115.38	66.38			181.76	545.28
	2006		-0.55	25.95			25.40	76.20
	2007		162.49	73.87			236.36	709.08
	2009		184.21	99.31			283.52	850.56
W-Sun-F	Avg	170.79			-9.05	-22.98	138.76	277.52
	2006	71.98			-29.72	-18.24	24.02	48.04
	2007	276.66			52.74	-20.20	309.20	618.40
	2009	163.73			-50.17	-30.50	83.06	166.12
Average		185.85	115.59	79.78	-9.05	-22.98	217.57	552.47

The M/W-F rotation was started in 2006, therefore, there was no wheat planted in 2005 for the M/W-F.
The sunflowers were not harvested in 2006 and 2009 because of chemical damage.
No crops were harvested in 2008 because of drought.
Variable Net Income is gross income minus seed cost and weed control cost.

Crop Rotation Sequencing

Kevin Larson and Dennis Thompson

Crops differ in their utilization of water and nutrients. Some crops, such as sunflower, are believed to mine nearly all available soil water and nutrients and leave little for subsequent crops. Whereas, other crops, such as millet, use only a portion of the available water and nutrients, leaving residual water and nutrients for subsequent crops. There are other advantages from crop rotation, including abatement of weeds, insects and diseases. The purpose of this study is to determine the crop rotation sequences that produce highest yields and incomes.

Materials and Methods

We tested fallow and five spring crops: sunflower, grain sorghum, corn, millet, and mung bean. Annually, each crop follows itself and every other crop. We planted corn (Mycogen @R577 Bt/RR) on May 80 at 12,500 seed/a, sunflower (Mycogen 8H419CL) on June 23 at 20,000 seed/a, grain sorghum (Mycogen 627) on June 17 at 32,500 seed/a, mung bean (Berken) on May 27 at 17 lb/a, and proso millet (Huntsman) on June 25 at 20 lb/a. Before planting we sprayed two applications of Glystar Plus at 24 oz/a and LoVol at 0.5 lb/a. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: millet and grain sorghum, Banvel 4 oz/a and 2,4-D amine 10 oz/a; corn, Roundup Weather Max 20 oz/a (two applications); mung bean, Prowl H2O 40 oz/a; sunflower, Prowl H2O 40 oz/a and Spartan 2 oz/a; and fallow, Glystar Plus 20 oz/a, Banvel 4 oz/a and LoVol 0.5 lb/a (two applications). We harvested the crops with a self-propelled combine equipped with a digital scale: millet, September 10; grain sorghum, November 4; corn, October 20; mung bean, October 19; and the sunflowers were not harvested because of chemical damage.

This is the sixth cropping year of this dryland crop rotation sequencing study. In 2003, the first year the rotations were started, all crops were planted in fallow. The second year, 2004, the crops were planted into the five crop stubbles and fallow. In 2005, we decided to change the rotations, based on the 2004 results, to obtain the highest potential yield and income, and still have all five crops and fallow represented. We planted the 2005 crops in the different locations where the 2003 crops were originally planted: 2005 grain sorghum in 2003 millet, 2005 millet in 2003 mung bean, 2005 corn in 2003 fallow, 2005 mung bean in 2003 corn, 2005 sunflower in 2003 grain sorghum, and 2005 fallow in 2003 sunflower. In 2006, 2007, and 2009 we went back to the original rotations where all crops followed themselves and every other crop. No crops were harvested in 2008 because of drought.

Results and Discussion

The two-year rotation sequence with the highest variable net income was Sorghum-Sorghum with $300.01/a. The rotation that had the second highest variable net income for the previous two cropping years was Sorghum-Millet and its reciprocal Millet-Sorghum together produced an average variable net income of $271.55/a. This year the grain sorghum following fallow had the highest variable net income of $203.34/a, and Sorghum-Sorghum had the second highest variable net income of $197.49/a. Only sunflower and fallow produced negative net income averages for 2009 because fallow has no crop and the sunflower crop failed. The four-year rotation that produced the highest variable net income was continuous grain sorghum with $320.58/a. The four-year rotation and reciprocal rotation combination that came in a very close second was Sorghum-Millet with $311.85/a. Not surprisingly, the worst four-year rotation was continuous fallow. Continuous sunflower produced one of the lowest four-year rotations with -$96.46/a, because two out of four sunflower crops failed (chemical damage). Undoubtedly, sunflower in the rotations is at a disadvantage because of operator error negating crop yield. Currently, grain sorghum and millet have the highest overall variable net income and sunflower the lowest variable net income of the five crops and fallow tested in our dryland rotation sequencing study.

Table .-Crop Rotation Sequence Study, Yield Summary 2009.

	2009 Crop						2009 Average Total
Previous Crop	Grain Sorghum	Millet	Corn	Mung Bean	Sunflower	Fallow	Production
	---lb/a---						
Grain Sorghum	3606	2773	2822	113	0	0	1863
Fallow	3707	2330	2548	201	0	0	1757
Millet	2705	2050	1103	204	0	0	1212
Sunflower	1663	2217	1243	121	0	0	1049
Mung Bean	1876	1512	1680	102	0	0	1034
Corn	1837	767	493	182	0	0	656
Average	2566	1942	1648	154	0	0	1262
LSD 0.20	2137.4	965.6	1587.3	33.5			

There was no sunflower crop because of chemical damage.

Table .-Two-Year Crop Rotation Sequence, Variable Net Income Summary for 2007 and 2009.

	Total Variable Net Income for 2007 and 2009 Crops						Average 2-Year
	------------------------2009 Crop (2006 Stubble)---------------------						Variable
2007 Crop	Grain Sorghum	Millet	Corn	Fallow	Mung Bean	Sunflower	Net Income
	---$/a---						
Grain Sorghum	300.01	295.39	210.12	129.33	45.94	59.36	173.36
Millet	247.71	229.18	128.10	102.75	87.37	53.29	141.40
Corn	175.36	156.53	38.16	60.65	46.99	-45.22	72.08
Mung Bean	148.88	143.39	97.54	17.03	14.59	-7.28	69.03
Fallow	183.14	132.03	90.98	-46.96	-14.85	-71.17	45.53
Sunflower	98.27	157.94	29.55	-31.16	-21.19	-61.02	28.73
Average	192.23	185.74	99.08	38.61	26.48	-12.01	88.35

Variable Net Income: Gross Income - Seed Cost - Weed Control Cost.
The highest two-year variable net income of $300.01 was the Sorghum-Sorghum rotation.

Table .-Four-Year Crop Rotation Sequence, Variable Net Income Summary for 2005, 2006, 2007, and 2009.

	Total Variable Net Income for 2005, 2006, 2007, and 2009 Crops						Average 4-Year
	----------------------------2005 and 2007 Crops--------------------------						Variable
2006 and 2009 Crops	Grain Sorghum	Millet	Mung Bean	Fallow	Sunflower	Corn	Net Income
	---$/a---						
Grain Sorghum	320.58	304.79	144.13	236.31	124.95	131.77	210.42
Millet	318.90	269.13	171.31	155.01	196.47	80.42	198.54
Corn	166.04	114.94	41.71	41.05	0.39	-55.62	51.42
Fallow	165.81	144.87	10.28	-85.71	-9.26	-0.97	37.50
Mung Bean	34.27	117.69	-33.11	-54.15	-48.11	-23.31	-1.12
Sunflower	21.32	40.25	-48.91	-121.40	-96.46	-78.01	-47.20
Average	171.15	165.28	47.57	28.52	28.00	9.05	74.93

Variable Net Income: Gross Income - Seed Cost - Weed Control Cost.
The highest four-year variable net income of $320.58 was the GS-GS-GS-GS rotation.

Table .-Grain Sorghum: Crop Rotation Sequencing Study, Walsh, 2009.

Previous Crop	2009 Grain Sorghum Seed Yield	2009 Grain Sorghum Gross Income	2009 Grain Sorghum Variable Net Income	2007 Grain Sorghum Variable Net Income	2006 Grain Sorghum Variable Net Income	2005 Grain Sorghum Variable Net Income	4-Year Average Variable Net Income
	bu/a	$/a	$/a	$/a	$/a	$/a	$/a
Fallow	66	215.15	203.34	156.09	73.68	54.72	121.96
Grain Sorghum	64	209.30	197.49	102.52	3.28	17.29	80.15
Corn	33	106.60	94.79	80.57	0.08	-2.41	43.26
Millet	48	156.98	145.17	112.19	0.08	11.38	67.20
Sunflower	30	96.53	84.72	110.33	0.08	-8.32	46.70
Mung Bean	34	108.88	97.07	53.79	6.48	5.47	40.70
Average	46	148.90	137.09	102.58	13.95	13.02	66.66
LSD 0.20	38.2	123.65	113.84	54.45	7.97	8.80	

Planted: Grain Sorghum (Mycogen 627) on June 17, 2009 at 32,500 seed/a.
Grain Sorghum Seed Cost: $3.83/a ($1.70/lb).
Harvested: Grain Sorghum November 4, 2009.
Grain Sorghum Market Price $3.25/bu.
Weed Control: Banvel, 4 oz; 2,4-D amine, 10 oz.
Chemical Cost: $2.48/a; Application Cost $5.50/a.
Variable Net Income: Gross Income - Seed Cost - Weed Control.

Table .-Millet: Crop Rotation Sequencing Study, Walsh, 2009.

Previous Crop	2009 Millet Grain Yield	2009 Millet Gross Income	2009 Millet Variable Net Income	2007 Millet Variable Net Income	2006 Millet Variable Net Income	2005 Millet Variable Net Income	4-Year Average Variable Net Income
	bu/a	$/a	$/a	$/a	$/a	$/a	$/a
Fallow	42	163.07	152.23	129.51	43.49	60.36	96.40
Grain Sorghum	50	194.04	183.20	102.54	12.13	57.00	88.72
Corn	14	53.70	42.86	113.67	9.78	26.76	48.27
Millet	37	143.47	132.63	96.55	3.11	36.84	67.28
Sunflower	40	155.23	144.39	104.26	5.47	16.68	67.70
Mung Bean	27	105.84	95.00	81.57	27.03	43.56	61.79
Average	35	135.89	125.05	104.68	16.83	40.20	71.69
LSD 0.20	17.2	66.78	61.45	19.53	7.21	11.79	

Planted: Millet (Huntsman) on June 25, 2009 at 20 lb/a.
Millet Seed Cost: $2.86/a ($8/bu).
Harvested: Millet on September 10, 2009.
Millet Market Price $3.92/bu.
Weed Control: Banvel, 4 oz; 2,4-D amine, 10 oz.
Chemical Cost: $2.48/a; Application Cost $5.50/a.
Variable Net Income: Gross Income - Seed Cost - Weed Control.

Table .-Corn: Crop Rotation Sequencing Study, Walsh, 2009.

Previous Crop	2009 Corn Seed Yield	2009 Corn Gross Income	2009 Corn Variable Net Income	2007 Corn Variable Net Income	2006 Corn Variable Net Income	2005 Corn Variable Net Income	4-Year Average Variable Net Income
	bu/a	$/a	$/a	$/a	$/a	$/a	$/a
Fallow	46	170.63	111.18	118.44	-29.42	-43.38	39.20
Grain Sorghum	50	189.00	129.55	136.81	-41.67	-48.91	43.95
Corn	9	33.00	-26.45	-19.19	-44.47	-49.31	-34.86
Millet	20	73.88	14.43	21.69	-39.92	-49.23	-13.26
Sunflower	22	83.25	23.80	31.06	-35.02	-49.53	-7.42
Mung Bean	30	112.50	53.05	60.31	-42.02	-49.23	5.53
Average	29	110.38	50.93	58.19	-38.75	-48.26	5.52
LSD 0.20	28.4	108.10	49.88	14.37	-34.44	-8.36	

Planted: Corn (Mycogen 2R577 Bt/RR) on May 18, 2009 at 12,500 seed/a.
Corn Seed Cost: $28.13/a ($2.25/1000 seeds).
Harvested: Corn on October 20, 2009.
Corn Market Price $3.75/bu.
Weed Control: Roundup Weather Max, 20 oz/a (two applications).
Chemical Cost: $20.32/a; Application Cost $11/a.
Variable Net Income: Gross Income - Seed Cost - Weed Control.

Table .-Mung Bean: Crop Rotation Sequencing Study, Walsh, 2009.

Previous Crop	2009 Mung Bean Seed Yield	2009 Mung Bean Gross Income	2009 Mung Bean Variable Net Income	2007 Mung Bean Variable Net Income	2006 Mung Bean Variable Net Income	2005 Mung Bean Variable Net Income	4-Year Average Variable Net Income
	lb/a	$/a	$/a	$/a	$/a	$/a	$/a
Fallow	201	30.15	5.35	-10.81	-18.79	11.49	-3.19
Grain Sorghum	113	16.95	-7.85	-19.61	-17.14	-4.81	-12.35
Corn	182	27.30	2.50	-12.71	-24.79	-13.81	-12.20
Millet	204	30.60	5.80	-10.51	-13.24	0.89	-4.27
Sunflower	121	18.15	-6.65	-18.81	-23.59	-11.91	-15.24
Mung Bean	102	15.30	-9.50	-20.71	-26.29	-21.41	-19.48
Average	154	23.08	-1.73	-15.53	-20.64	-6.59	-11.12
LSD 0.20	33.5	3.46	0.57	13.86	-14.54	2.67	

Planted: Mung Bean (Berken) on May 27, 2009 at 17 lb/a.
Mung Bean Seed Cost: $6.80/a ($40/cwt).
Harvested: Mung Bean on October 19, 2009.
Millet Market Price $0.15/lb.
Weed Control: Prowl H2O 40 oz/a.
Chemical Cost: $12.50/a; Application Cost $5.50/a.
Variable Net Income: Gross Income - Seed Cost - Weed Control.

Table .-Sunflower: Crop Rotation Sequencing Study, Walsh, 2009.

Previous Crop	2009 Sunflower Seed Yield	2009 Sunflower Gross Income	2009 Sunflower Variable Net Income	2007 Sunflower Variable Net Income	2006 Sunflower Variable Net Income	2005 Sunflower Variable Net Income	4-Year Average Variable Net Income
	lb/a	$/a	$/a	$/a	$/a	$/a	$/a
Fallow	0	0.00	-50.97	-4.40	-29.72	40.14	-11.24
Grain Sorghum	0	0.00	-50.97	13.55	-29.72	20.20	-11.74
Corn	0	0.00	-50.97	5.75	-29.72	5.86	-17.27
Millet	0	0.00	-50.97	13.55	-29.72	33.06	-8.52
Sunflower	0	0.00	-50.97	-10.05	-29.72	-5.72	-24.11
Mung Bean	0	0.00	-50.97	-14.54	-29.72	-3.33	-24.64
Average	0	0.00	-50.97	0.64	-29.72	15.04	-16.25
LSD 0.20				10.39		37.77	

Planted: Sunflower (Mycogen 8H419CL) on June 23, 2009 at 20,000 seed/a.
Sunflower Seed Cost: $25/a ($1.25/1000 seeds).
Harvested: not harvested because of chemical damage.
Sunflower Market Price $0.13.50/lb.
Weed Control: Prowl H2O, 40 oz; Spartan, 2 oz.
Chemical Cost: $20.47/a; Application Cost $5.50/a.
Variable Net Income: Gross Income - Seed Cost - Weed Control.

Table .-Fallow: Crop Rotation Sequencing Study, Walsh, 2009.

Previous Crop	Seed Yield	Gross Income	2009 Fallow Variable Net Income	2007 Fallow Variable Net Income	2006 Fallow Variable Net Income	2005 Fallow Variable Net Income	4-Year Average Variable Net Income
	bu/a	$/a	$/a	$/a	$/a	$/a	$/a
Fallow	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
Grain Sorghum	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
Millet	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
Mung Bean	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
Corn	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
Sunflower	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
Average	0	0.00	-26.76	-20.20	-18.24	-20.51	-21.43
LSD 0.20							

Weed Control: Glystar 20 oz; 2,4-D ester 0.5 lb, Banvel 4 oz/a (two applications).
Chemical Cost: $15.76/a; Application Cost $11/a.
Variable Net Income: Gross Income - Seed Cost - Weed Control.

Water Storage and Precipitation Impacts on Wheat and Sorghum Yields Over 22 Years At Stonington (Bill Wright Farm)

L.A. Sherrod, L.R. Ahuja, N.C. Hansen, K. Larson, D. Thompson, D. Harn, C. Thompson.

The dryland cropping system experiment has been a collaborative research focus between Colorado State University and USDA Agricultural Research Service to evaluate and monitor the sustainability of cropping systems with greater intensity than crop-fallow. The objectives are 1) to identify systems that make the most use of precipitation, and are economically and environmentally sustainable under no-till management 2) monitor both grain and stover yields and surface soil organic matter of these systems across a gradient of soils and climates and 3) compare these systems within wet and dry years and over the continuum. A common intensified cropping practice adopted in no-till management is a 3 year system of winter wheat – corn or sorghum – summer fallow rotation. Here we examine the wheat and sorghum grain yields from a wheat-sorghum-fallow (WSF) cropping system under wet years (first 12 years) and over 22 years of cropping.

Materials and Methods

The dry weight of both wheat and sorghum yields were predicted by the amount of soil water at planting, amount of fallow rainfall, amount of vegetative rainfall, and amount of reproductive rainfall across 22 years of cropping history by using multivariate analysis. We evaluated these relationships by comparing the level of significance (p-value). The smaller this value of probability is, the heavier the weight of the sample evidence against the null hypotheses is. The experimental null hypotheses being that there is no relationship between yield and the 4 variables used to account for it. The other statistical value we used to evaluate the relationship of grain yield and water storage and precipitation timing was the correlation coefficient (r). This value measures the linear strength of the relationship between these variables and it lies between -1 and +1. The rainfall period for the wheat crop fallow rain was the 14 month period of July through August. The vegetative rainfall period of 8 months was from September through April and the reproductive rainfall period was May and June. The sorghum crop fallow rainfall period was 10 months from July through April. The vegetative rainfall for sorghum was taken to be May and June with the reproductive rainfall period used was July and August. Data was primarily taken from the weather station on site with only minor use of the Plainsman Station data being used to fill in gaps when the station was down.

Results

Wheat yields were significantly correlated to water storage and precipitation timing for the summit and toeslope soil positions during the first 12 years of the experiment with the most significant variable explaining yield being soil water at planting and fallow period rainfall (Fig. 1). This relationship was even stronger when looking over a 22 year period with all three slope positions showing a significant relationship to yield with fallow rainfall and soil water at planting along with vegetative rainfall being significant in the prediction of wheat grain yields

(Fig. 2). The average wheat yields over 22 years and after 12 years did not change significantly and was therefore a good crop for avoiding drought (Fig. 3).

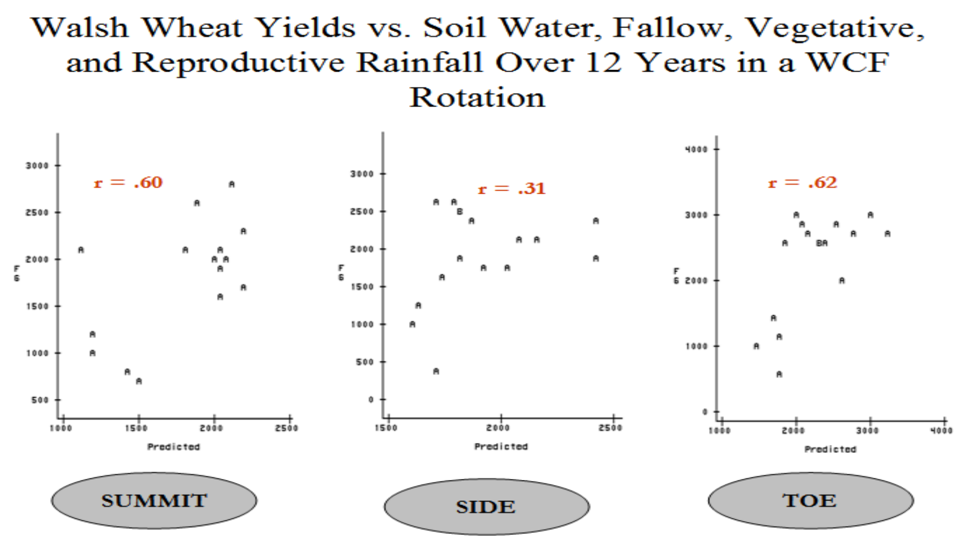

Figure 1. Wheat grain yield (F6) as predicted by soil water at planting, fallow rainfall, vegetative rainfall and reproductive rainfall over 1986 through 1997 cropping history.

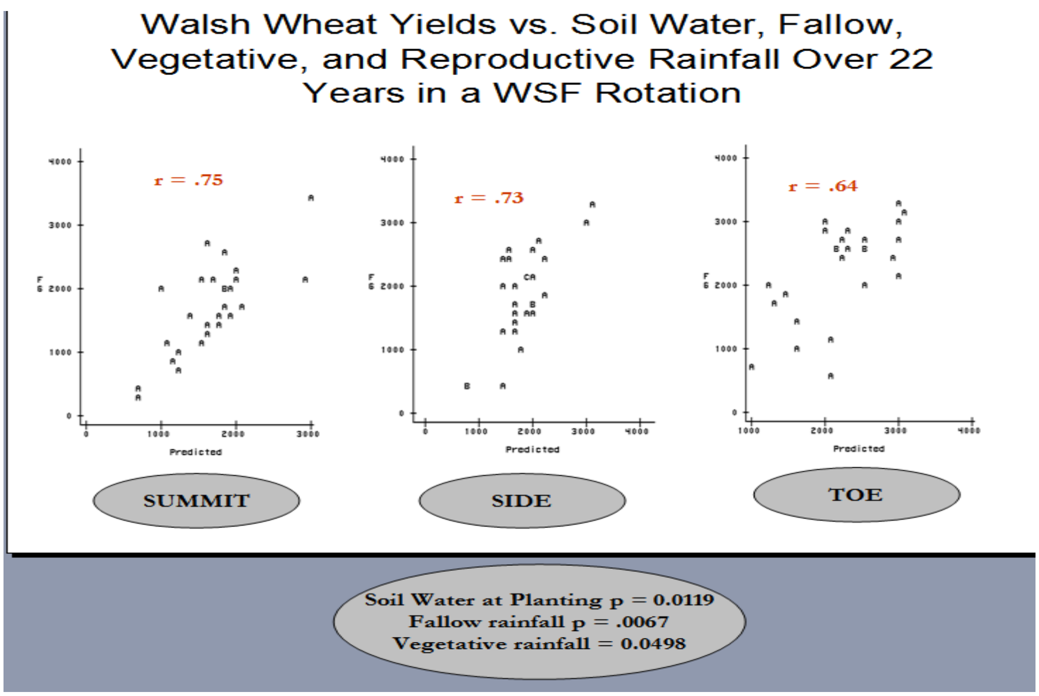

Figure 2. Wheat grain yield (F6) as predicted by soil water at planting, fallow rainfall, vegetative rainfall and reproductive rainfall over 1986 through 2007 cropping history.

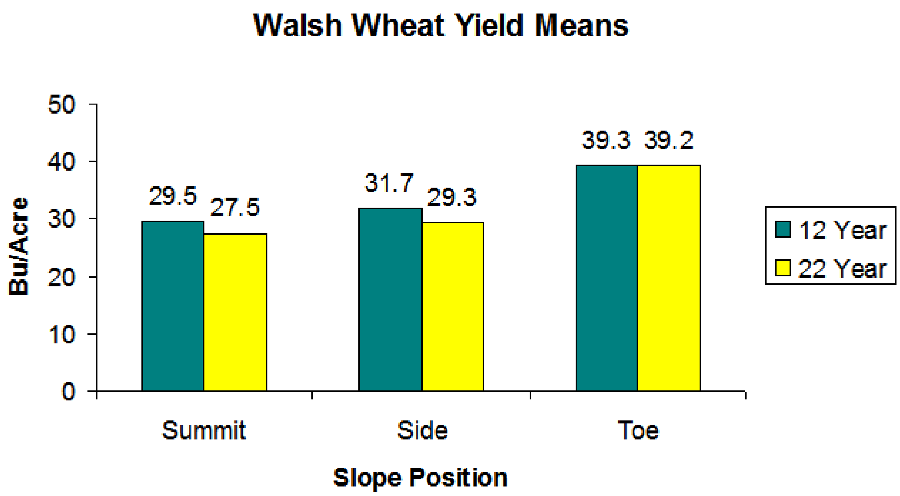

Figure 3. Average dry wheat grain yield by soil slope position as compared to wet years (86-97) and over the complete cropping history through 2007.

Sorghum yields were somewhat predicted using only the 1st 12 years of data with the summit soil showing the strongest correlation (r = 0.60) (Fig. 4). However, when looking over the 22 year period all slope positions showed a significant correlation with the strongest relationship found on the toeslope soil position (Fig. 5). The most significant variables in this regression with sorghum yields were soil water at planting and reproductive rainfall. The average sorghum yields over 22 years and after 12 years did show a reduction in yield over time as expected by the recent drought years but only in the toeslope soil position (Fig. 6).

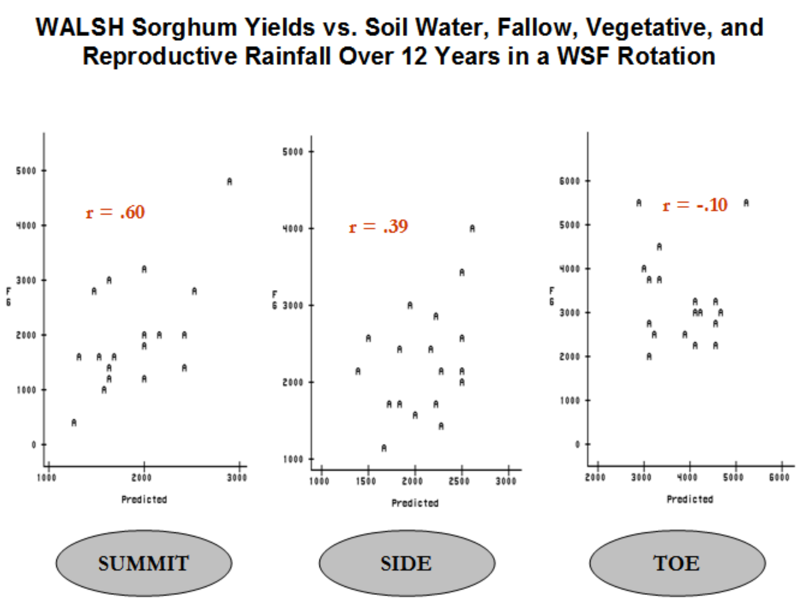

Figure 4. Sorghum dry grain yield (F6) as predicted by soil water at planting, fallow rainfall, vegetative rainfall and reproductive rainfall over 1986 through 1997 cropping history.

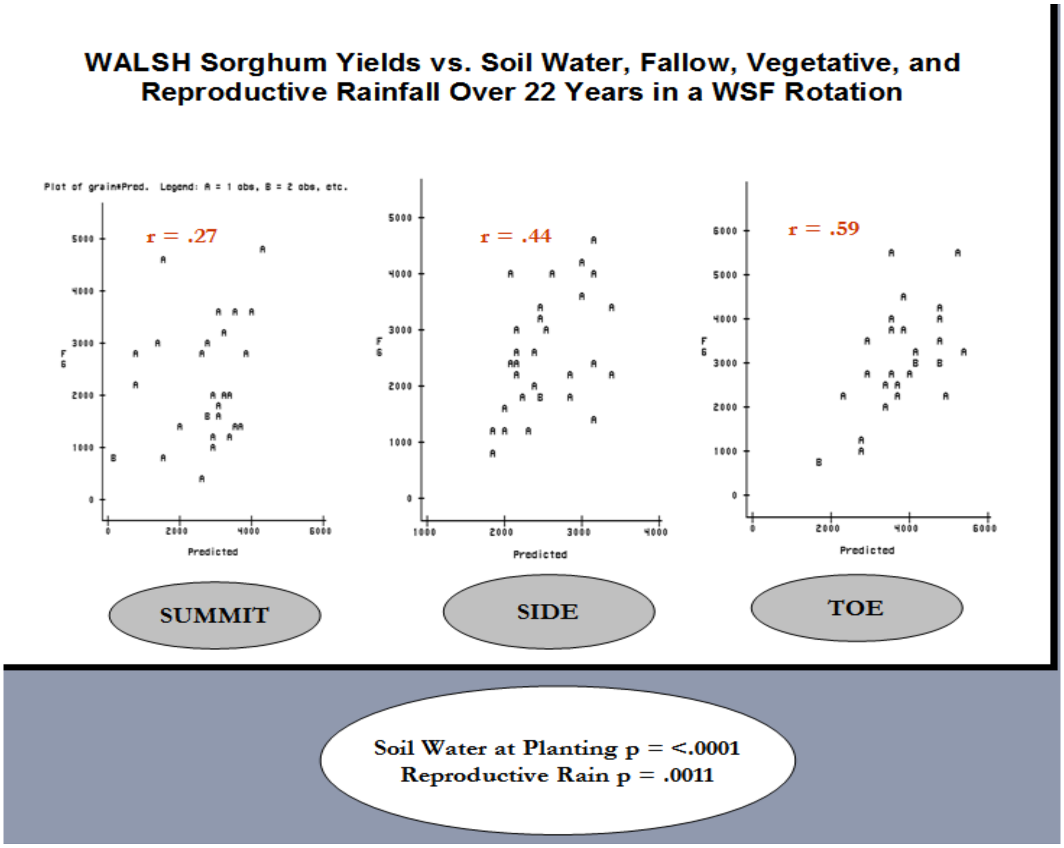

Figure 5. Sorghum dry grain yield (F6) as predicted by soil water at planting, fallow rainfall, vegetative rainfall and reproductive rainfall over 1986 through 2007 cropping history.

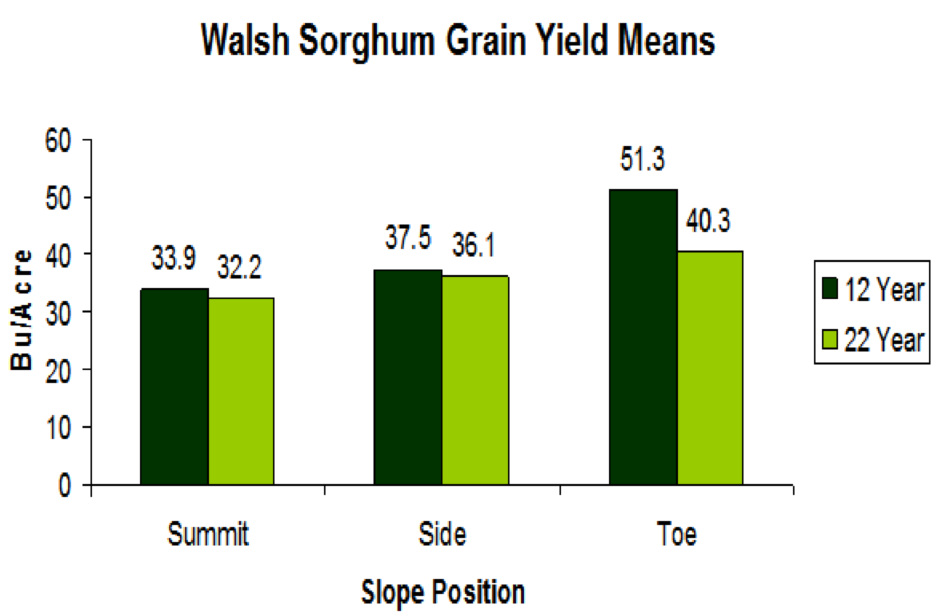

Figure 6. Average dry sorghum grain yield by soil slope position as compared to wet years (86-97) and over the complete cropping history through 2007.

Discussion

Predictions of wheat and sorghum yields were best when using the complete 22 year dataset. The variables that were the most significant in the prediction of wheat yields was soil water at planting and the amount of water received during the fallow period. Wheat did a good job of avoiding the drought on average with a 32 bu/Acre yield across soils over the 22 year period. The variables that were the most significant in the prediction of sorghum yields were also soil water at planting but included reproductive rainfall that is received in July and August. The sorghum yields were significantly impacted by the drought on average but just on the toeslope soil position. This was not expected as we assumed the summit and sideslope soils that have a sandy soil texture would be more severely impact by the drought. This was not show when averaged over 22 and 12 year means. The variability of rainfall in the spring for wheat reproductive period and sorghum planting is lower than the variability of rain during the reproductive period of the summer crop. Changing to a more diverse cropping system with less fallow duration and frequency optimizes the rainfall that is received in this semi-arid environment. This system divides the risk across each phase within the system and validates what researchers and producers have observed with this 3 year cropping system.

Dryland Millet and Wheat Rotation Study

Kevin Larson and Dennis Thompson

This is the second year of harvest for our dryland millet and wheat rotation study. We established these rotations to identify which millet and wheat and fallow rotation sequence produces the highest net income. Each rotation represents different fallow length. We began this new dryland rotation study with these six rotations in 2006: 1) Wheat-Fallow (15-month fallow period), 2) Wheat-Wheat (3-month fallow period), 3) Millet-Millet (8-month fallow period), 4) Wheat-Millet-Fallow (23-month fallow period, 11 months between wheat harvest and millet planting, and 12 months between millet harvest and wheat planting), 5) Millet/Wheat-Fallow, (no fallow between millet harvest and wheat planting and 11 months between wheat harvest and millet planting), and 6) Wheat/Millet-Fallow (no fallow between wheat harvest and millet planting and 11 months between millet harvest and wheat planting).

Materials and Methods

This is our second harvest-year in testing the following rotations: Wheat-Fallow (W-F), Wheat-Wheat (W-W), Millet-Millet (M-M), Wheat-Millet-Fallow (W-M-F), Millet/Wheat-Fallow (M/W-F), and Wheat/Millet-Fallow (W/M-F). We planted wheat, Hatcher, at 50 lb/a on October 1, 2008 and Proso millet, Huntsman, at 20 lb/a on June 25, 2009. We applied 50 lb N/a to the study site. Before planting we sprayed two applications of Glystar Plus at 24 oz/a and LoVol at 0.5 lb/a. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: wheat, Express 0.33 oz/a, LoVol 0.38 lb/a, and Penetrant II 8 oz/a; millet (except W/M-F) Banvel 4 oz/a and amine 10 oz/a; and fallow, Glystar Plus 20 oz/a, Banvel 4 oz/a and LoVol 0.5 lb/a two times. For the millet in the W/M-Fallow rotation, we applied Glystar 24 oz/a and Atrazine 0.75 lb/a. The M/W-Fallow rotation received an additional 20 oz/a of Glystar after millet harvest. We harvested the crops with a self-propelled combine equipped with a digital scale: wheat, July 1 and millet, September 29. No wheat was planted in the W/M-F rotation and no millet was planted in the M/W-F rotation. We recorded cost of production and yields in order to determine rotation revenues. There were no harvested crops in 2008 because of drought.

Results and Discussion

The W-M-F rotation produced the highest variable net income of $248.47/a, and the second highest total crop production of 3785 lb/a for 2009, when both wheat and millet crops are combined. However, the W-M-F rotation is a two crops in three years rotation, therefore on an annualized basis its variable net income is $72.66/a per year and its total annualized crop production is 1262 lb/a per year. On an annualized basis, the W-W rotation produced the highest variable net income of $105.30/a and the highest annualized crop production of 1608 lb/a. The M/W-F rotation had the lowest annualized variable net income, $32.87/a, and the lowest annualized total crop production, 960 lb/a, because no wheat was planted in this rotation. When we project these rotations over a six-year cycle, the W-W rotation provides the highest total crop production of 11394 lb/a. However, since this is the only the second cropping year for these rotations, the rotational effects are just beginning and 6-year projections have little meaning.

We are still in the establishment phase with these rotations and we already have had crop failures and missed plantings, therefore rotational affects are, at best, difficult to generalize and quantify. In 2009, abundant spring and summer moisture produced good yields for most crops this year with the wheat and millet producing similar yields. No crops were harvested in 2008 because of drought. Winter wheat performed better than millet in both yield and income in 2007. In 2007, it was too dry for the millet planted immediately after wheat harvest (millet in the W/M-F) to establish a stand. We missed planting wheat in the M/W-F rotation in 2008. In 2009, we did not plant millet in the W/M-F rotation because of delayed volunteer wheat control.

Table .-Dryland Millet and Wheat Rotation Study, Walsh, 2009.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
	lb/a	$/a	$/a	bu/a	$/a	$/a	$/a
Wheat	50	6.67	15.33	29.9	4.75	142.03	120.03
W-F	50	6.67	15.33	33.0	4.75	156.75	134.75
W-W	50	6.67	15.33	26.8	4.75	127.30	105.30
W-M-F	50	6.67	15.33	29.1	4.75	138.23	116.23
M/W-F	50	0.00	27.39	0	4.75	0.00	-27.39
W/M-F	50	6.67	15.33	30.7	4.75	145.83	123.83
Millet	20	2.86	7.98	23.1	3.92	90.55	79.71
M-M	20	2.86	7.98	21.6	3.92	84.67	73.83
W-M-F	20	2.86	7.98	36.5	3.92	143.08	132.24
M/W-F	20	2.86	7.98	34.3	3.92	134.46	123.62
W/M-F	20	0.00	16.19	0	3.92	0.00	-16.19
Fallow	---	---	30.50	---	---	0.00	-30.50
Average			36.53			232.58	56.41

Planted: Millet, Huntsman at 20 lb/a on June 25; Wheat, Hatcher at 50 lb/a on October 1, 2008.
Harvested: Millet on September 29, 2009; Wheat on July 1, 2009.
Wheat herbicides: Express 0.33 oz/a, 2,4-D, 0.38 lb/a; Wheat hericide cost: $9.83/a.
Millet herbicides: Banvel 4 oz/a, 2,4-D amine 10 oz/a: Millet herbicide cost: $2.48/a
Fallow herbicides: Gylstar Plus 20 oz/a, 2,4-D 0.5 lb/a, Banvel 4 oz/a;
Fallow herbicide cost: $19.50/a (two application, $9.75/a per application)
Wheat in M/W-F additional herbicide: Glystar 20 oz/a.
Millet in W/M-F herbicides: Glystar 24 oz/a, Atrazine 0.75 lb/a; W/M-F herbicide cost: $10.69/a.
Weed control cost is herbicide cost and $5.50/a application cost for each application.

Table .-Dryland Millet and Wheat Rotations, Second Year, Walsh, 2009.

Rotation	Millet Test Weight	Millet Yield	Wheat Test Weight	Wheat Yield	2009 Total Prod.	2007 Total Prod.	2-Year Total Prod.	Projected 6-Year Total Production
	lb/bu	lb/a	lb/bu	lb/a	lb/a	lb/a	lb/a	lb/a
W-F			60	1980	1980	2640	4620	6930
W-W			60	1608	1608	2190	3798	11394
M-M	56	1212			1212	1478	2690	8070
W-M-F	56	2042	60	1743	3785	3813	7598	7598
M/W-F	57	1920		0	1920	3850	5770	8655
W/M-F		0	60	1842	1842	2532	4374	6561
Average	56	1294	48	1435	2058	2751	4808	8201
LSD 0.20		317.9		159.9				

Rotations: W, wheat; M, millet; F, fallow. M/W-F, wheat planted same year as millet was harvested; W/M-F, millet planted same year as wheat was harvested.
Planted: Wheat, Hatcher at 50 lb/a on October 1, 2008.
Harvested: Wheat on July 1, 2009.
Planted: Millet, Huntsman at 20 lb/a on June 25, 2009.
Harvested: Millet on September 29, 2009.
Millet in W/M-F was not planted.
Wheat in M/W-F was not planted.
There were no crops harvested in 2008 because of drought.
Yields were adjusted to 12.0% seed moisture for both wheat and millet.

First Annual Report (2009) for Sun Grant Initiative South Central Region

Expanding Production Area and Alternative Energy Crop Market of Proso Millet for Water Deficient Lands

Kevin Larson, Rick Kochenower, and Jeffrey Tranel

Proso millet is a low water-use, low input crop. It is an ideal crop for water deficient lands, such as contract-expired CRP lands. Expanding the production area of proso millet will require development of a new end-use market. Currently, proso millet is used almost exclusively for birdseed. The birdseed market is limited and expansion is improbable. The feed grain market with recent exponential growth is ethanol. Most ethanol production in the United States is from corn. If proso millet replaces some of the corn as an ethanol feedstock, expansion of proso millet production would occur. The purpose of this study is two-fold: 1) to determine if proso millet is viable crop outside of its traditional production area and 2) to determine if proso millet is a viable ethanol crop. If our objectives for proso millet are successful, production area expansion (into new dryland areas) and market expansion (as a new ethanol feedstock) will be realized.

Material and Methods

We planted proso millet at two sites, the Plainsman Research Center at Walsh, Colorado and the Oklahoma Panhandle Research and Extension Center at Goodwell, Oklahoma. We planted four proso millet cultivars at four incremental planting dates throughout July, 2009. Three of the cultivars were standard starch cultivars: Huntsman, Sunrise, and Horizon. The fourth cultivar was a waxy starch cultivar, Plateau. The four planting dates at Walsh were: PD1, July 1; PD2, July 10; PD3, July 20; and PD4, July 31, 2009. The four planting dates at Goodwell were: PD1, July 7; PD2, July 14; PD3, July 21; and PD4, July 28, 2009. The experimental designs were split-plots with planting dates as the main plot and cultivars as the subplots with four replications. The plot size at Walsh was 10 ft. by 50 ft. (harvested 10 ft. by 44 ft.). The plot size at Goodwell was 5 ft. by 35 ft. (harvested 5 ft. by 30 ft.). Both sites were irrigated to assure seed germination. All cultivars and planting dates were seeded at 15 lb/a. Nitrogen was the only fertilizer applied, 50 lb/a at Walsh and 100 lb/a at Goodwell. For weed control at Walsh, the entire site had a preplant application of glyphosate 24 oz/a and 2,4-D ester 0.5 lb/a, and a post emergence application of dicamba 4 oz/a and 2,4-D amine 0.38 lb/a. For weed control at Goodwell, the entire site had a preplant application of atrazine 1.0 lb/a, and no post emergence herbicides were applied. Both sites were harvested with a self-propelled combines equipped with conventional grain heads. Grain yields, test weights, and seed moistures were recorded. The harvest dates at Walsh were: PD1, September 29; PD2, October 16; PD3 and PD4, October 17. The harvest dates at Goodwell were: PD1, September 14 and PD3 October 19. At Goodwell, the July 14 planting date (PD2) did not establish an adequate stand and was eliminated from the study, and the July 28 planting date (PD4) was not harvested because of excessive rainfall.

Results

The first planting dates at both sites produced the highest average grain yield, 1645 lb/a at Walsh and 1450 lb/a at Goodwell (Tables 1 and 2). The planting date ranking for grain yield at Walsh was: PD1>>PD2>PD3=PD4 (Table 3). The planting date ranking at Goodwell was PD1>PD3 (Table 4). Huntsman produced the highest yield at all harvested planting dates at both sites, although Huntsman was not significantly different than Sunrise at Walsh, and Huntsman only significantly out yielded Plateau at Goodwell. Grain yield ranking of the four cultivars was consistent for all four planting dates at Walsh: Huntsman=Sunrise>Horizon>Plateau (Table 3 and Figure 1). The relative ranking of the four cultivars for the two harvested planting dates at Goodwell was: Huntsman>Sunrise=Horizon>Plateau, although the only significant difference was between Huntsman and Plateau (Table 4 and Figure 3).

Test weights significantly decreased with later planting dates at Walsh (Table 3 and Figure 2), but increased, although not significantly, between the two harvested planting dates (PD1 and PD3) at Goodwell (Table 4 and Figure 3). Huntsman had the highest overall test weight at both sites, 56.9 lb/bu at Goodwell and 54.6 lb/bu at Walsh.

The first two planting dates and the last two planting dates at Walsh had similar lodging percentages, PD1, 9.1%; PD2, 9.2%; PD3, 4.4%; and PD4, 5.3% (Table 1). Of the four cultivars, Plateau had the highest plant lodging at all planting dates and was the only cultivar that had double-digit lodging.

Plant height consistently decreased with later planting dates at Walsh (Table 1). The plant height ranking from tallest to shortest was: Huntsman, Sunrise, Horizon, and Plateau.

At Walsh, date to 50% heading averaged 33 days after planting (DAP) for all planting dates and cultivars (Table 1). With later planting dates, date of 50% heading became increasingly earlier for all cultivars, except Plateau. Plateau was the earliest maturing cultivar tested and its date to 50% heading remained at 30 to 31 DAP for the first three planting dates then dropped to 29 DAP at the last planting date. Date to 80% maturity, when the crop was ready for swathing, averaged 61 DAP for all planting dates and cultivars. Like heading, date to 80% maturity was earlier with later planting dates for all cultivars, except Plateau. Date of maturity of Plateau remained 58 to 59 DAP for all four planting dates.

Discussion

For the first year of this study, we evaluated only July planting dates for proso millet production. The first planting dates (July 1 for Walsh and July 7 for Goodwell) produced the highest yield. There was a significant yield decrease between PD1 and PD2 at Walsh (990 lb/a yield drop), and the yield difference between the two harvested planting dates (PD1 and PD3) at Goodwell of 267 lb/a was also significant. This suggests that early July planting is critical for high yields at Walsh and Goodwell, but with the small yield decrease, the planting window maybe longer at Goodwell. Test weights decreased significantly with later planting dates at Walsh, but they actually increased at Goodwell, although the test weight increase was not significant. Delayed planting, past early July, does not appear to have the severe yield and test weight penalty at Goodwell as it does at Walsh. Nonetheless, the highest yield averages were from the first planting dates at both sites. From these initial results, we recommend planting proso millet no later than early July. This recommendation may change with the greater range of planting dates planned for next year and with ethanol yield analyses from the various planting dates.

Of the four proso millet cultivars tested, Huntsman had the highest average yield at both sites. However, Huntsman did not have significantly higher yield than Sunrise at Walsh, and Huntsman was only significantly better than Plateau at Goodwell. The cultivar choice for high yields is not as evident as is the choice for planting date. This year, Huntsman appears to have a marginal yield advantage compared to the other three cultivars. Cultivar choice may change with the results from the expanded planting dates planned for next year. Also, after fermentation and distillation of the harvested grain, the cultivars may more readily be separated by their ethanol production.

Table 1.--Proso Millet: Planting Dates and Cultivars, Walsh, CO, 2009.

Cultivar	Seed Yield	Test Weight	Moisture	Lodging	Plant Height	50% Heading	80% Maturity
	lb/a	lb/bu	%	%	in	DAP	DAP
PD1 - July 1							
Huntsman	2137	56.5	12.9	3.5	27	39	66
Sunrise	1956	56.3	13.1	5.3	26	38	65
Horizon	1411	56.0	13.0	7.5	24	36	64
Plateau	1076	53.5	12.9	20.0	21	30	58
PD1 Average	**1645**	**55.6**	**13.0**	**9.1**	**25**	**36**	**63**
PD2 - July 10							
Huntsman	981	55.8	14.4	4.3	21	36	63
Sunrise	940	54.5	14.3	4.5	20	35	62
Horizon	490	54.4	14.3	0.5	19	34	61
Plateau	208	54.1	14.8	27.5	16	30	58
PD2 Average	**655**	**54.7**	**14.5**	**9.2**	**19**	**34**	**61**
PD3 - July 20							
Huntsman	429	54.1	14.8	0.0	18	34	62
Sunrise	399	53.9	14.7	0.0	16	34	62
Horizon	139	55.0	14.7	0.0	16	33	61
Plateau	151	53.5	14.6	17.5	13	31	59
PD3 Average	**280**	**54.1**	**14.7**	**4.4**	**16**	**33**	**61**
PD4 - July 31							
Huntsman	365	51.9	17.1	0.0	16	32	59
Sunrise	316	51.5	17.3	3.0	14	32	59
Horizon	229	51.3	16.9	3.0	15	30	58
Plateau	201	50.7	16.9	15.0	12	29	58
PD4 Average	**278**	**51.4**	**17.1**	**5.3**	**14**	**31**	**59**
Average	714	53.9	14.8	7	18	33	61
LSD 0.05	272.1	0.94	0.71	8.71			

Harvested: PD1, Sept. 29; PD2, Oct. 16; PD3, Oct. 17; PD3, Oct. 17, 2009.
DAP is days after planting.
Seed yields adjusted to 13% seed moisture content.

Table 2.--Proso Millet Planting Dates and Cultivars Seed Yield Summary at Goodwell, OK, 2009.

	--------PD1 - July 7-------			--------PD3 - July 21------		
Cultivar	Seed Yield	Test Weight	Moisture	Seed Yield	Test Weight	Moisture
	lb/a	lb/bu	%	lb/a	lb/bu	%
Huntsman	1686	56.4	14.4	1558	57.3	13.3
Sunrise	1498	54.8	14.0	1065	57.6	12.9
Horizon	1450	55.4	13.6	1234	55.5	13.0
Plateau	1168	52.4	13.2	873	54.7	12.4
Mean	1450	54.8	13.7	1183	56.3	12.9
LSD 0.05	NS	NS	0.4	NS	NS	NS
CV %	23	3	2	27	3	16

Seed Yield is adjusted to 13.0% seed moisture content.

Table 3.--Proso Millet Planting Dates and Cultivar Summary at Walsh, 2009.

	Seed Yield		Test Weight		Seed Moisture	
	lb/a		lb/bu		%	
Planting Date						
PD1 - July 1	1645	a	55.6	a	13.0	a
PD2 - July 10	655	b	54.7	b	14.4	b
PD3 - July 20	280	c	53.9	c	14.7	b
PD4 - July 31	278	c	51.3	d	17.0	c
PD LSD 0.05	160.8		0.44		0.35	
Cultivar						
Huntsman	978	a	54.6	a	14.8	a
Sunrise	903	a	54.0	b	14.8	a
Horizon	567	b	53.9	b	14.7	a
Plateau	409	c	53.0	c	14.8	a
Cultivar LSD 0.05	135.2		0.49		0.37	
Average	715		53.9		14.8	

Seed Yield is adjusted to 13% seed moisture content.

Table 4.--Proso Millet Planting Dates and Cultivar Summary at Goodwell, 2009.

	Seed Yield		Test Weight		Seed Moisture	
	lb/a		lb/bu		%	
Planting Date						
PD1 - July 7	1450	a	54.7	b	13.8	a
PD3 - July 21	1183	b	56.3	a	12.9	a
PD LSD 0.05	91.2		2.31		2.33	
Cultivar						
Huntsman	1622	a	56.9	a	13.8	a
Sunrise	1282	ab	56.3	a	13.5	a
Horizon	1342	ab	55.4	ab	13.3	a
Plateau	1021	b	53.5	b	12.8	a
Cultivar LSD 0.05	354.0		1.97		1.88	
Average	1317		55.5		13.4	

Seed Yield is adjusted to 13% seed moisture content.

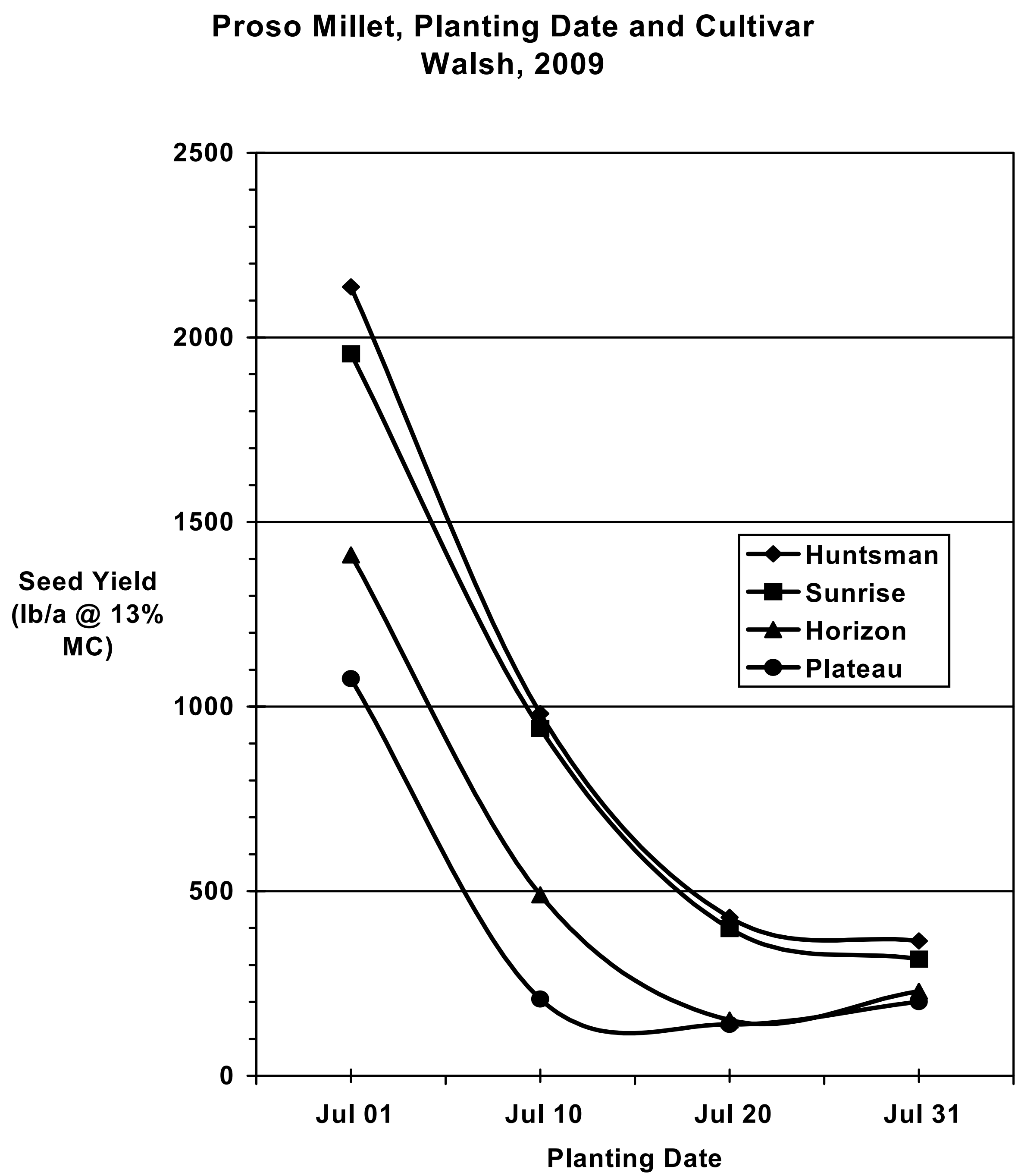

Fig. 1. Seed yield of proso millet planting dates and cultivars for ethanol production study at Walsh, CO, 2009. The planting dates were: PD1, July 1; PD2, July 10; PD3, July 20; and PD4, July 31. The cultivars were: Huntsman, Sunrise, Horizon, and Plateau. All planting dates and cultivars were seeded at 15 lb/a. Harvest dates were: PD1, September 29; PD2, October 16; PD3 and PD4, October 17.

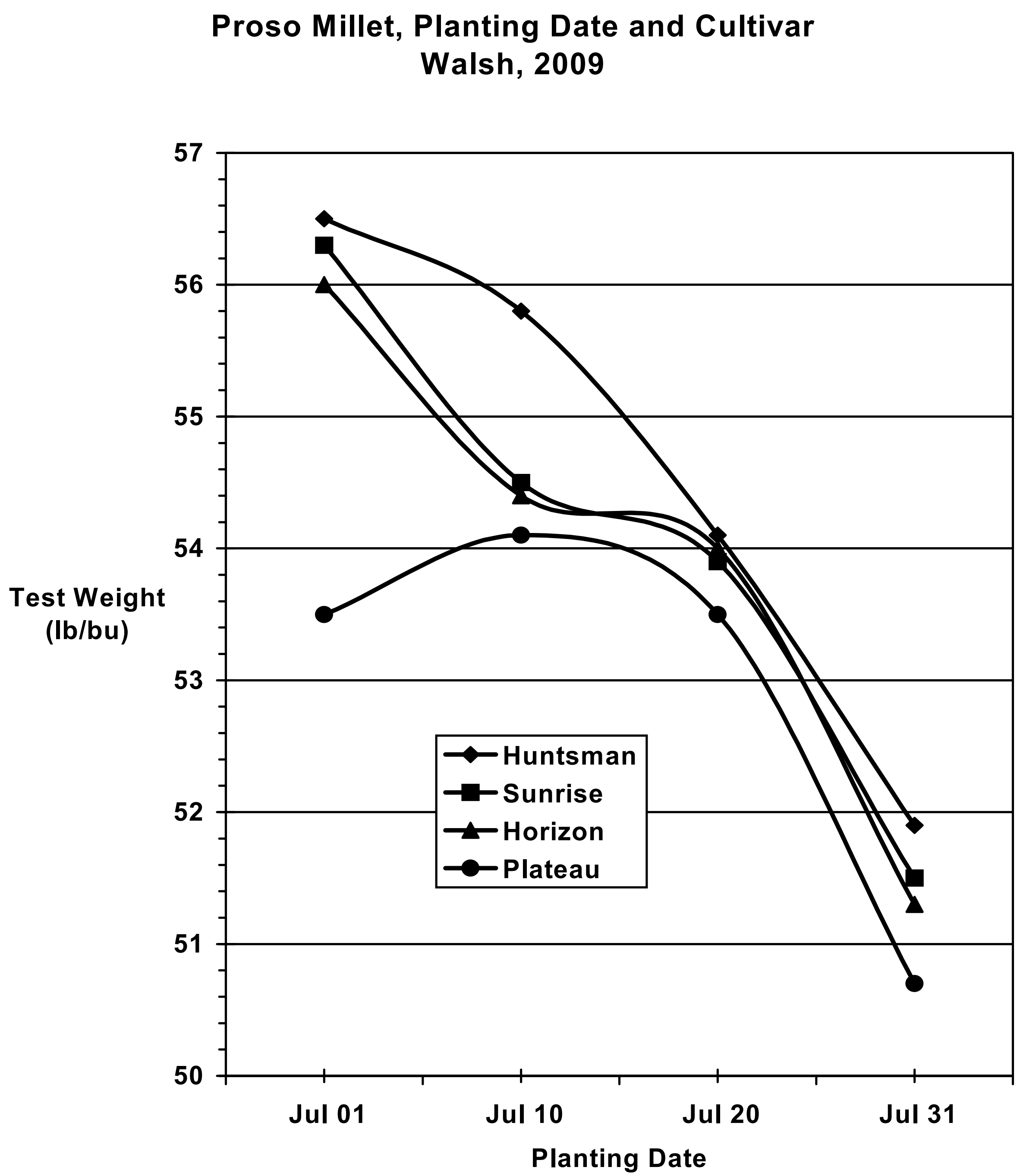

Fig. 2. Test weight of proso millet planting dates and cultivars for ethanol production study at Walsh, CO, 2009. The planting dates were: PD1, July 1; PD2, July 10; PD3, July 20; and PD4, July 31. The cultivars were: Huntsman, Sunrise, Horizon, and Plateau. All planting dates and cultivars were seeded at 15 lb/a. Harvest dates were: PD1, September 29; PD2, October 16; PD3 and PD4, October 17.

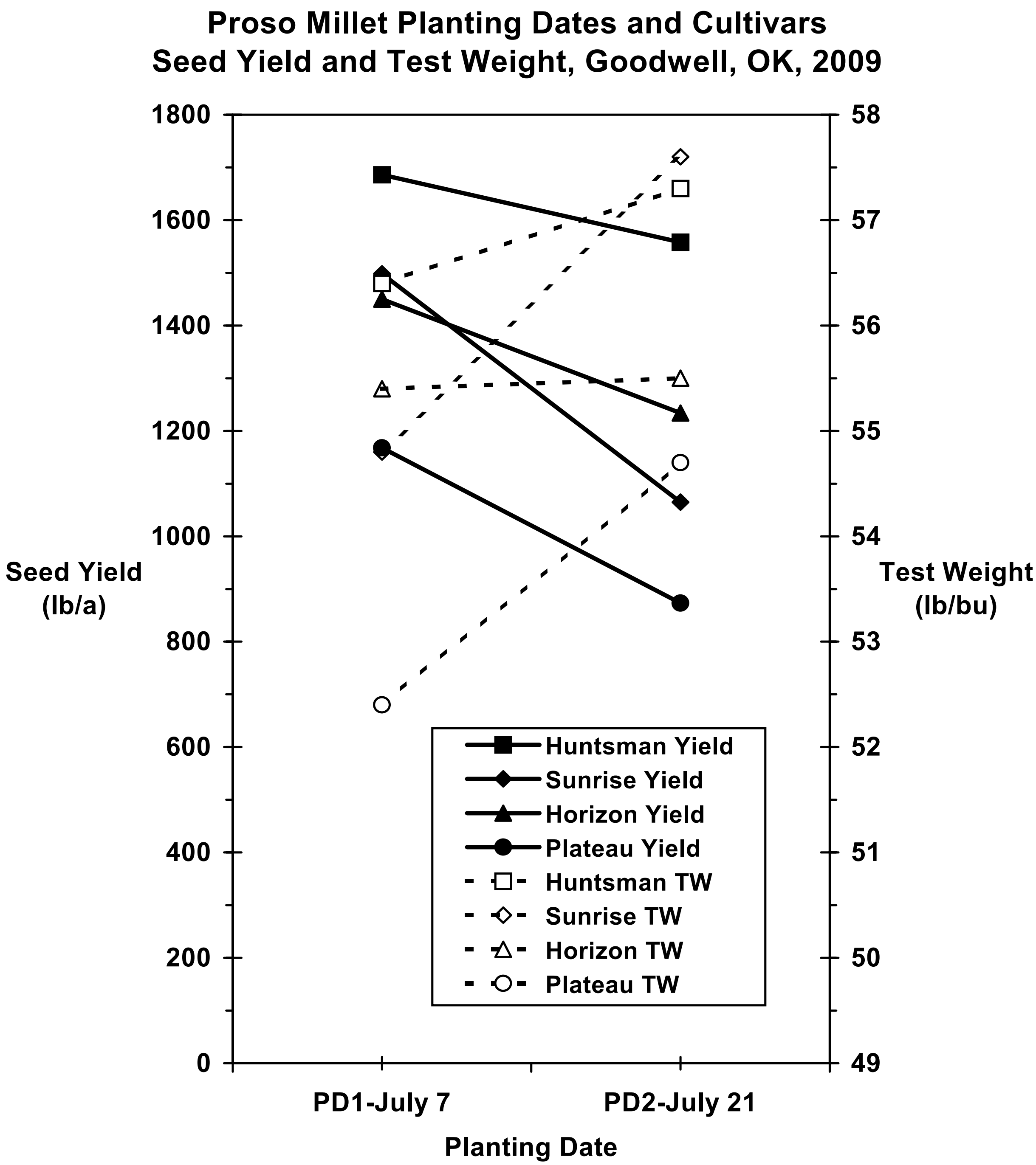

Fig. 3. Seed yield and test weight of proso millet planting dates and cultivars for ethanol production study at Goodwell, OK, 2009. The harvested planting dates were: PD1, July 7; and PD3, July 21, 2009. The cultivars were: Huntsman, Sunrise, Horizon, and Plateau. All planting dates and cultivars were seeded at 15 lb/a. Harvest dates were: PD1, September 14; and PD3, October 19. Seed yield is adjusted to 13.0% seed moisture content.

Irrigated Mid and High Oleic Sunflower Hybrid Performance Trial at Walsh, 2009

COOPERATORS: Plainsman Agri-Search Foundation, and Kevin Larson, Superintendent, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under irrigated conditions with 2300 sorghum heat units in a Silty Loam soil.

PLOT: Four rows with 30” row spacing, 650’ long. SEEDING DENSITY: 26,000 seed/a. PLANTED: June 24. HARVESTED: November 11.

IRRIGATION: Subsurface Drip Irrigated: total water applied approximately 10 a-in./a.

PEST CONTROL: Preemergence Herbicides: Glyphosate 24 oz/a, Spartan 2.0 oz/a, Prowl H2O 40 oz/a. Post Emergence Herbicides: None. CULTIVATION: Once. INSECTICIDES: Warrior (Sunflower Head Moth control).

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------No. of Days--------		
June	0.00	178	6	1	6
July	7.92	824	19	5	37
August	1.75	712	15	0	68
September	2.50	467	5	0	98
October	0.52	81	1	0	108
Total	12.69	2262	46	6	108

\1 Growing season from June 24 (planting) to October 10 (first hard freeze, 23 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

FIELD HISTORY: Last Crop: Grain sorghum. FIELD PREPARATION: No-till.

COMMENTS: Planted in good soil moisture. Weed control was good, but because of drift downwind areas had low plant stands. Above normal precipitation for the growing season with a very wet July. Warror was applied to control head moth. Seed harvested from areas of higher plant stands. Seed yields were good.

SOIL: Silty Loam for 0-8” and Silty Loam 8”-24” depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.7	0.7	2.0	27	2.1	554	0.5	2.6
8”-24”				25				
Comment	Alka	VLo	Hi	VHi	VLo	VHi	Lo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	50	40	0	0
Applied	150	0	0	0

Yield Goal: 2500 lb/a.
Actual Yield: 2020 lb/a.

Drip Irrigated Sunflower, Mid and High Oleic Variety Trial, PRC, Walsh, 2009.

Firm	Hybrid	Mid or High Oleic	50% Flower	Plant Density	Plant Ht.	Test Wt.	Oil	Seed Yield	Oil Yield
			date	plants/a (X1000)	in	lb/bu	%	lb/a	lb/a
MYCOGEN	8N453DM	mid	8/22	16.0	58	32	44.5	2386	1061
TRIUMPH	s671	mid	8/22	14.4	41	31	43.6	2148	937
TRIUMPH	s678	mid	8/25	18.0	45	28	40.6	2219	902
TRIUMPH	664	mid	8/24	12.4	50	28	40.6	2025	823
TRIUMPH	s878HO	high	8/24	13.6	44	30	39.9	1908	761
TRIUMPH	845HO	high	8/24	10.8	51	25	41.7	1817	758
PIONEER	63N82	mid	8/24	11.6	51	27	40.2	1877	754
MYCOGEN	8H419CL	high	8/23	13.2	56	27	40.2	1783	716
Average			8/23	13.8	50	29	41.4	2020	839
LSD 0.20								222.0	

Planted: June 24; Harvested: November 11, 2009.
Seed Yield adjusted to 10% seed moisture content.
Total water applied was 10 in./a of drip irrigation.
Plant densities were low due to herbicide damage.

Dry Bean Trial, Row Crop Head and Hand Harvest Comparison, Walsh, 2009

Kevin Larson and Mark Brick

PURPOSE: To test the suitability of dry bean varieties (9 pinto beans and 3 black bean) for direct row crop head harvesting.

MATERIALS and METHODS: We planted 9 pinto bean varieties and 3 black bean varieties into a site of failed winter canola. For our plot design, we used a RCBD with four replications. We fertilized the site with 50 lb N/a as 32-0-0. We planted the beans on May 27 at 22,000 seeds/a. To control weeds, we applied Prowl H2O at 40 oz/a, and hand cultivated. We hand harvested a 2.5 ft. by 5 ft. area in each plot on November 21. We machine harvested the remaining 10 ft. by 44 ft. plot using a row crop head on November 28.

RESULTS: The hand harvested averaged 168 lb/a and the machine harvested averaged 628 lb/a. The 460 lb/a difference between machine harvested and hand harvested represents the seed yield left behind by machine harvesting. When machine harvested, there was no significant difference between the highest yielding variety, Cahone, and the next four top yielding varieties, (LSD 0.05). When hand harvested, there were significant yield differences between the highest yielding variety, Cahone, and all three black bean varieties (LSD 0.05). Hail damage, which caused leaf area and pod losses, reduced the yield potential of the dry beans in this study.

DISCUSSION: This is the third edible dry bean trial that we have had at Plainsman since 1993. The renewed interest in dry beans occurred because of high dry bean prices. The reason we tested direct head harvest was to minimize soil loss. Dry beans leave little residue to protect against wind erosion, even before undercutting which leaves soils especially vulnerable. Direct harvesting with a row-crop head leaves a large amount of unharvested seedpods in the field. The large yield difference between the higher-yielding, hand harvested varieties and direct machine harvesting is due the inability of our row crop head to get low enough to harvest short plants and low pod sets caused by hail recovery. We are, however, encouraged by the 877 lb/a hand harvested yield of Cahone under these conditions.

Table .Dryland Dry Bean Trial, Walsh, 2009.

Variety	Bean Type	Hand Harvested Yield	Row Head Harvested Yield
		lb/a	lb/a
Cahone	Pinto	877	256
Croissant	Pinto	665	243
CO 34142	Pinto	667	223
Grand Mesa	Pinto	653	200
Condor	Black	549	188
29113	Black	518	169
Shiny Crow	Black	443	166
CO 54311	Pinto	493	153
Montrose	Pinto	715	128
Bill Z	Pinto	587	126
Fisher	Pinto	732	89
Othello	Pinto	632	70
Average		628	168
LSD 0.05		300.1	74.3

Planted: May 27, 2009 at 22,000 seeds/a
Weed Control: Prowl H2O 40 oz/a and
hand cultivated.
Hand Harvested: November 21, 2.5 ft X 5 ft.
Row Head Harvested: November 28, 10 ft X 44 ft

National Winter Canola Variety Performance and Great Plains Trials, Walsh 2009

Kevin Larson, Mike Stamm, and Dennis Thompson

Purpose: To identify the best adapted, highest yielding varieties of winter canola.

Results and Discussion

There was good soil moisture at planting, therefore we did not have to irrigate for seed germination. For our area, it is atypical to have adequate soil moisture for planting winter canola. This is because its small seed requires shallow planting depths and its narrow planting window (late August to mid-September) is too short for sufficient rain to occur. This year, however, we had good germinating moisture and excellent stands. This past winter was dry and cold and none of the varieties and lines survived the winter. This scenario of a dry and cold winter resulting in severe canola winterkill has happened a few times in the last decade. To see if we could improve the winter survival of canola, we have begun an irrigation timing study. We believe that adequate soil moisture prior to spring re-growth is one of the keys to winter survival. In this new study, we are applying irrigation in the fall, winter, or spring on four winter canola varieties that have a range of tolerance to winterkilling conditions. Hopefully our inclinations are correct and one of these irrigations will ameliorate winterkilling conditions in canola.

Since all of the canola varieties winterkilled, there was no harvest and only stand notes are recorded in the following tables.

Materials and Methods

We planted 51 winter canola varieties and lines for the National Winter Canola Trial and 36 winter canola varieties and lines for the Great Plains Winter Canola Trial on September 11, 2008. The trial was planted at 5 lb seed/a with a 12 in. row-spaced drill to a depth of 1.5 inches in good soil moisture. We stream-applied 50 lb N/a as 32-0-0 on 18 in. spacing. No other fertilizers were applied. For weed control, we applied Treflan 24 oz/a prior to planting (incorporated with 0.25 in. of rain the same night). The canola was not harvested because all varieties and lines winterkilled.

Table .--National Winter Canola Variety Trial, 2009.

Variety (Line)	Stand (0 to 10)	Winter Survival (0 to 10)
Baldur	9.5	0
Kronos	7.5	0
HyClass154W	8.8	0
Visby	8.8	0
Dimension	9.9	0
Flash	9.2	0
Hornet	8.5	0
Safran	8.8	0
Sitro	8.3	0
ARC2189-2	9.0	0
ARC00005-2	9.4	0
ARC00024-2	8.8	0
ARC00004-2	9.0	0
45D03	9.7	0
46W14	9.5	0
46W99	9.2	0
Hybristar	8.5	0
Hybrigold	9.3	0
Hybrisurf	9.2	0
Hybrilux	8.9	0
Kadore	8.8	0
KS3074	9.4	0
KS3132	8.0	0
KS3254	8.5	0
KS4022	8.8	0
KS4085	8.3	0
KS4158	8.9	0
Kiowa	8.0	0
Sumner	9.0	0
Wichita	8.8	0
Virginia	8.8	0
BSX-501	8.5	0
BSX-6131	8.8	0
BSX-6242	9.4	0
BSX-6271	8.3	0
BSX-6406	8.3	0
AAMU-18-07	8.8	0
AAMU-33-07	8.8	0

Variety (Line)	Stand (0 to 10)	Winter Survival (0 to 10)
HyClass107W	9.3	0
HyClass110W	8.5	0
HyClass115W	8.0	0
Hearty	8.3	0
Rossini	9.7	0
DKW41-10	8.8	0
DKW45-10	8.3	0
DKW46-15	8.5	0
DKW47-15	8.3	0
CWH633	8.8	0
CWH111	9.0	0
CWH095D	9.8	0
CWH101D	9.4	0
Average	8.8	0
LSD 0.20	0.76	

Great Plains Canola Variety Trial, 2009.

Variety (Line)	Stand (0 to 10)	Winter Survival (0 to 10)
KS4409	9.0	0
KS4443	9.0	0
KS4112	8.8	0
KS4424	8.8	0
Wichita	8.8	0
Virginia	8.7	0
KS4138	8.5	0
KS4404	8.3	0
KS4426	8.3	0
KS4459	8.3	0
KS4461	8.3	0
SIU331	8.3	0
KS9135	8.3	0
KS4106	8.0	0
KS4083	8.0	0
KS4395	8.0	0
Sumner	8.0	0
KS4416	7.8	0
KS4436	7.8	0
KS4031	7.5	0
KS4155	7.5	0
KS4280	7.5	0
KS4419	7.5	0
KS4035	7.3	0
KS4033	7.0	0
KS4323	7.0	0
KS4433	7.0	0
KS4134	6.8	0
SIU182	6.5	0
KS4124	6.3	0
KS4192	6.3	0
KS4314	6.3	0
KS4018	6.0	0
KS4023	6.0	0
KS4127	6.0	0
KS4191	4.5	0
Average	7.6	0
LSD 0.20	1.13	