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Alternative Crops and Cropping Systems in Southwestern North Dakota

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Abstract

Crop production systems in southwestern North Dakota are dominated by cereals. Production of these crops for grain has been plagued by pests and other problems. The development of alternative production methods, and the production of other grain and seed crops, is needed to improve cropping systems. The objectives of this research were: (1) to determine if peas and other annual crops and/or crop combinations can be grown successfully for forage compared with oats; (2) identify pulse crops that are adapted to growing conditions in southwestern North Dakota, and management practices that optimize pulse crop production; and (3) identify oilseed crops that can be grown profitably in southwestern North Dakota. To do this, several experiments were conducted, each having a randomized complete block design with four replications. Results of these experiments showed a general trend for annual legumes to produce less forage than cereals in side-by-side comparisons ($P < .05$. The crude protein (CP) concentration of legume forage generally was higher than that of cereal forage. In-row applications of N and P fertilizer did not enhance pea seed yield or quality, nor did seeding rates > 300 000 pure live seed (PLS)/acre). Seed yield averaged 791 lb/acre for six mustard, 1610 lb/acre for nine safflower cultivars, and 25 bu/acre for five flax cultivars in 1998. Gross returns averaged $106.74/acre, $193.18/acre, and $116.37 for mustard, safflower, and flax, respectively. By comparison, gross returns averaged $156.09/acre for hard red spring wheat. These data suggest

that economic returns generated by safflower compared favorably to those generated by wheat in 1998.

Introduction

Cereals are the most widely grown, cultivated crops in the northern Great Plains. These crops are well adapted to the cool semiarid climate of the region. However, economic projections suggest that alternatives to cereal crops must be grown, or new markets developed, for crop production systems to be viable across the northern Great Plains in the future. Diversifying cropping systems is a greater challenge in southwestern North Dakota compared with most other regions of the state, since fewer crops traditionally have been grown in the southwest region (Ball, 1987).

The objectives of this project were to:

1. Identify corn hybrids that are superior for forage and grain yield.
2. Determine if peas and other annual crops or crop combinations are superior to oat for forage.
3. Identify commercially available lentil and pea cultivars that are adapted to growing conditions in southwestern North Dakota, and determine optimum production practices for growing pulse crops.
4. Identify oilseed crops that are adapted to growing conditions in southwestern North Dakota.

Materials and Methods

All experiments except the flax adaptation experiment were located at Dickinson. Plots in all experiments were arranged in a randomized complete block with blocks replicated four times. Cultural practices including tillage and seeding, fertilization, and herbicide application followed currently acceptable agronomic procedure in all experiments. Data were analyzed by ANOVA using SAS (SAS Inst., 1985). Where F tests showed significant differences ($P < 0.05$) among treatments, means were separated using Fischer's protected LSD.

Objective 1

Corn

Twelve corn cultivars were compared for forage moisture content and yield, grain yield, and grain test weight.

Objective 2

Cool-season, annual forages

Barley, oat, triticale, Indianhead lentil, Trapper pea, and selected combinations were compared for forage moisture content, yield, crude protein (CP) concentration, acid- and neutral-detergent fiber concentration (ADF and NDF, respectively). Cereal plants were harvested at the milky to early soft dough stage of kernel development. Pea and lentil were harvested during flowering, soon after the first pods had formed. Cereal-pea combinations were harvested when the cereal component was at the milky to early soft dough stage of kernel development.

Varying harvest dates for barley, oat, pea, lentil, and selected cereal-pea combinations

This experiment is discussed elsewhere in the annual report (see article by Patrick M. Carr and Woodrow (Chip) W. Poland entitled Integrating Crop and Livestock Systems with Pulses and Cereal-Pea Intercrops.)

Objective 3

Pea and Lentil production for forage and seed

Pea and Lentil experiments are discussed elsewhere in the annual report (see article by Patrick M. Carr and Woodrow (Chip) W. Poland entitled Integrating Crop and Livestock Systems with Pulses and Cereal-Pea Intercrops.)

Fertilizing peas for seed production

The effect of different, in-row N and P fertilizer treatments with Carneval peas at planting were compared. In-row fertilizer treatments included: 6, 12, and 18 lb/acre urea (46-0-0); 25, 50, and 75 lb/acre MAP (11-52-0); and 30, 60, and 90 lb/acre TSP (0-45-0). Data collected in each plot included pea plant population, grain yield, and test weight.

Seeding rate comparisons for maximum pea seed yield

Five seeding rates (200 000, 250 000, 300 000, 350 000, and 400 000 PLS/acre) were compared. Data collected included pea plant population, grain yield, test weight, and seed weight.

Objective 4

Mustard
Days to flowering, flower duration, plant height, seed yield, bushel test weight, and seed weight were compared among six mustard cultivars.

Safflower
Days to flowering, plant height, seed yield, seed oil concentration, bushel test weight, and seed weight were compared among nine safflower cultivars.

Flax
Plant height, seed yield, bushel test weight, and seed weight were compared among five flax cultivars at Beulah, Glen Ullin, and Hannover, ND.

Results and Discussion

Objective 1

Corn
Average silage yield was 4.1 tons of dry matter (DM)/acre for the 12 cultivars evaluated at Dickinson in 1998 (Table 1). Silage yield ranged from 3.4 tons DM/acre for the 80-d cultivar Proseed 180 to 4.7 tons DM/acre for the 88-d cultivar Dekalb DK-385 B. The 108-d, high-sugar, silage cultivar Cargill HS60A produced less forage than Dekalb DK-385 B. Forage quality may have been superior for the Cargill HS60A cultivar compared with the Dekalb DK-385 B cultivar; however, forage quality was not determined in this experiment.

Silage was harvested at an average moisture content of 65.8% (Table 1). Corn should be harvested for silage at a moisture content of 63% to 70%.

Grain yield averaged 59 bu/acre for the 12 cultivars (Table 1). Bird feeding damage reduced yield by an estimated

27%. These estimates suggest that grain yield averaged 81 bu/acre for the corn cultivars. Differences in grain yield were not detected among the cultivars because of the confounding effects of bird feeding prior to grain harvest.

Bushel test weight averaged 55.8 lb/bu for the 12 cultivars (Table 1). Heaviest test weights were produced by the following cultivars: 88-d Dekalb DK-385 B, 84-d Cropland max 40, 78-d Cropland 154, and 80-d Proseed 180.

Objective 2

Cool-season annual forages

Forage yield among the 12 cereal and legume treatments averaged 2.9 tons DM/acre in 1998 (Table 2). Haybet barley produced more forage than Paul oat, Trapper pea, and Indianhead lentil. Similar amounts of forage were produced by Haybet and Stark barley, 2700 triticale, Whitestone oats, and cereal-pea combinations.

Yield was unaffected by intercropping cereal with pea crops compared with cereal sole crops (Table 2). Conversely, forage yield was increased by intercropping pea with 2700 triticale or Whitestone oat compared with sole pea. Intercropping pea with Paul oat did not increase forage yield compared with the sole pea treatment.

Forage was harvested at a moisture content ranging from 64% for barley cultivars to 75% for pea and lentil sole plots (Table 2).

The CP concentration of Indianhead lentil forage was greater than the CP concentration of other crops or crop mixtures in 1998, as was the CP concentration of lentil forage was in 1997 (Table 2). The CP concentration of Trapper pea forage was greater than the CP concentration of forage of sole cereal treatments. There was a consistent but non-significant trend for forage CP concentration to increase when peas were intercropped compared with sole cereal plots.

The ADF and NDF concentration of lentil forage was less than ADF and NDF concentration of pea, cereal, and cereal-pea mixtures in 1998 (Table 3). These data and the forage CP concentration data suggest that Indianhead lentil produces higher quality forage compared with other treatments included in Table 3.

Objective 3

Fertilizing peas for seed production

Pea seed yield was not increased by in-row applications of urea, MAP, or TSP (Table 4). Bushel weight and seed weight of peas also were unaffected by in-row fertilizer treatments. Fewer pea plants emerged and became established when MAP was applied at 50 and 75 lb/acre, or TSP was applied at 60 and 90 lb/acre. Results of this experiment concur with results of the experiment conducted near Beulah and Hannover in 1997 (Eriksmoen et al., 1997): there was no advantage in-row applications of N or P fertilizer provide regarding seed yield, test weight, or seed weight.

Seeding rate comparisons for maximum pea seed yield

Pea seed yield did not vary between seeding rates of 200 000, 250 000, 300 000, 350 000, and 400 000 PLS/acre for both Carneval and Trapper pea (Table 5). Pea bushel weight and seed weight were unaffected by seeding rate changes. Plant population was less when peas were seeded at <300 000 PLS/acre compared with 350 000 and 400 000 PLS/acre. These preliminary data suggest that present seeding rate recommendations for peas of 325 000 to 350 000 PLS/acre may be higher than necessary for optimum seed yield.

Objective 4

Mustard

Seed yield averaged 791 lb/acre for the six mustard cultivars compared (Table 6). Differences among the six mustard cultivars did not exist for yield or gross returns. AC Vulcan and Forge produced seed with a lower test weight than seed produced by other cultivars. Seed size also was smaller for AC Vulcan and Forge. Flowering was delayed for these two cultivars compared with other cultivars, resulting in a shorter flowering period. This shortened flowering period for AC Vulcan and Forge may have resulted in the smaller seed size and lighter test weight.

Safflower

The cultivar S 518 produced more seed than any other cultivar (Table 7). Conversely, Erlin produced less seed than other cultivars, except Montola 2000, Montola 2001, Morlin, and Finch. The bushel weight of Finch seed was heavier than that of other cultivars, while the seed weight of Finch was similar to that of S 317, S 518, and S 541..

The seed oil content ranged from 34.5% for Finch to 38.9% for Centennial (Table 7). The seed oil content of the fatty acid modified Montola 2000 and Montola 2001 were 36%.

Flax

No data were collected from flax plots at Glen Ullin because of emergence and other problems. Flax seed yield averaged only 8.5 bu/acre at Beulah because of dry conditions before and during the growing season (Table 8). Flax seed yield averaged 25 bu/acre at Hannover.

Differences in gross returns did not exist among flax cultivars in 1998 at Beulah and Hannover (Table 8). Gross returns averaged $116.37/acre for flax cultivars grown at Hannover, and < $40/acre for flax grown at Beulah.

Bushel weight of flax averaged 49.8 lb/bu at Beulah and 56.6 lb/bu at Hannover (Table 7). Seed weight was 148 178 seeds/lb at Beulah and 85 368 seeds/lb at Hannover. Differences between cultivars for bushel and seed weight did not exist at either location.

Conclusions/implications of Research

Objective 1

The corn cultivar Dekalb DK-385 B produced more silage than the high-sugar, silage cultivar Cargill HS60A in 1998. These data indicate that corn cultivars developed for silage production (HS60A) may not produce more forage than cultivars developed for grain production (DK-385 B). The results of this experiment do not answer a related question: is forage quality superior for cultivars developed for silage production compared with cultivars developed for grain production.

Grain yield averaged almost 60 bu/acre for 12 corn hybrids under dryland management in 1998. If birds had not damaged corn grain prior to harvested, we estimate average grain yields of over 80 bu/acre. These data suggest that corn hybrids are adapted to southwestern North Dakota for grain production.

Objective 2

No cool-season, annual crop was superior to oat for forage production in 1998. Barley and triticale sole crop, and cereal-pea intercrops, produced equal amounts of forage to oat sole crop. Less forage was produced by pea or lentil sole crop, but CP concentration was enhanced in legume forage compared with oat sole crop forage. These preliminary data suggest that annual legume crops may be preferred to oat if higher forage quality is desired.

Objective 2

Preliminary data suggest that variable costs associated with pea production can be reduced by modifying fertilizer and seeding rate practices. There was no advantage for in-row applications of N and P fertilizers to peas for seed yield, bushel weight, or seed weight. No advantage resulted for seed yield when peas were seeded at rates > 250 000 PLS/acre.

Objective 3

Higher gross returns were generated by safflower than spring wheat in 1998. Since variable costs associated with safflower and spring wheat are similar, these preliminary data suggest that safflower production may be more profitable than spring wheat production in southwestern North Dakota, under economic conditions similar to those encountered during this project.

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Table 1. Silage and grain yield of twelve corn cultivars in 1998 at Dickinson.

Brand	Hybrid	RM[1] days	Grain		Silage Yield				
					Harvest Moisture %	70% Moisture	DM Basis		
			Yield bu/ac	TW[2] lb/bu			1997	1998	2 yr avg
						Tons/acre			
Dekalb	DK-355	85	55.0	57.0	64	13.4	--	4.0	--
Dekalb	DK-385 B	88	51.7	57.5	66	15.7	5.1	4.7	4.9
Dekalb	DK-404SR	90	68.6	55.2	67	12.4	--	3.7	--
Dekalb	DK-405	90	60.3	55.4	67	14.5	--	4.3	--
Dekalb	DK-431	93	60.0	55.4	69	15.4	--	4.6	--
Dekalb	DK-493RR	99	70.2	53.2	69	14.7	--	4.4	--
Cargill	HS60A	108	33.2	51.8	73	12.9	--	3.9	--
Croplan	max 40	84	66.6	58.6	62	14.0	--	4.2	--
Croplan	154	78	59.7	57.4	57	12.6	--	3.8	--
Payco	4x85	85	64.0	56.2	64	13.3	--	4.0	--
Proseed	180	80	51.0	58.2	65	11.3	3.6	3.4	3.5

Proseed	185	85	68.6	54.0	66	12.4	4.3	3.7	4.0
Mean			59.1	55.8	65.8	13.6	--	4.1	--
C.V. %			16.6	1.6	3.1	12.7	--	12.7	--
LSD .05			NS	1.3	2.9	2.5	--	0.7	--

[1]RM=relative maturity
[2]TW=test weight

Table 2. Harvest moisture, yield, and crude protein (CP) concentration of forage produced by cool season, annual crops at Dickinson 1998.

Variety	Harvest Moisture			DM[1] Basis					
				Yield			CP		
	1997	1998	avg	1997	1998	avg	1997	1998	avg
	%			tons/ac			%		
Haybet barley	63	64	64	1.8	3.5	2.7	11.3	8.1	9.7
Stark barley	--	64	--	--	3.0	--	--	8.8	--
Trapper pea	78	75	77	1.4	2.5	2.0	13.4	14.8	14.1
Indianhead lentil	77	75	76	0.7	1.7	1.2	16.2	22.2	19.2
Aladin faba bean	83	--	--	0.6	--	--	18.0	--	--

2700 triticale	65	65	65	1.9	3.0	2.5	11.5	9.0	10.3
2700/Trapper	63	66	65	2.2	3.2	2.7	10.5	10.8	10.7
Paul oat	76	70	73	1.2	2.7	2.0	11.8	8.9	10.4
Paul/Trapper	75	70	73	1.5	2.9	2.2	12.6	11.3	12.0
Whitestone oat	69	67	68	1.6	3.3	2.5	10.1	7.6	8.9
Whitestone/Trapper	73	67	70	1.8	3.3	2.6	11.8	10.5	11.2
Robert oat/Trapper	75	--	--	1.5	--	--	12.3	--	--
Mean	73	68	70	1.5	2.9	2.2	12.7	11.2	11.8
C.V. %	4.8	3.7	--	17.0	14.1	--	13.0	18.9	--
LSD .05	10	4	--	NS	0.6	--	2.4	3.6	--
[1]DM = dry matter									

Table 3. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) concentration of forage of cool season, annual crops grown at Dickinson in 1998.

Variety	DM[1] Basis					
	ADF			NDF		
	1997	1998	avg	1997	1998	avg
	%					

Haybet barley	33	42	38	52	68	60
Stark barley	--	40	--	--	61	--
Trapper pea	46	49	48	51	55	53
Indianhead lentil	35	31	33	41	42	42
Aladin faba bean	49	--	--	51	--	--
2700 triticale	41	50	46	63	74	69
2700/Trapper	43	47	45	59	71	65
Paul oat	44	42	43	60	64	62
Paul/Trapper	45	43	44	53	61	57
Whitestone oat	44	44	44	65	67	66
Whitestone/Trapper	44	42	43	58	62	60
Robert oat/Trapper	42	--	--	56	--	--
Mean	42	43	43	55	62	59
C.V. %	6.7	5.6	--	5.3	4.6	--
LSD .05	4	4	--	4	5	--

[1]DM = dry matter

Table 4. Plant stand, seed yield, bushel weight, and seed weight for Carneval peas with and without in-row applications of N and P fertilizers at Dickinson in 1998.

Variety	Fertilizer rate lbs/ac	Fertilizer type	Plant stand plants/acre	Seeds per pound	Test weight lbs/bu	Seed yield lbs/acre
Carneval	0	NONE[1]	249,801	2,020	64.8	2,839
Carneval	6	urea	241,637	2,042	64.4	2,834
Carneval	12	urea	244,086	1,982	64.8	2,788
Carneval	18	urea	217,963	2,066	64.5	2,567
Carneval	25	MAP	219,596	1,999	64.1	2,877
Carneval	50	MAP	176,330	1,836	64.5	2,843
Carneval	75	MAP	144,493	1,888	64.8	2,580
Carneval	30	TSP	250,617	2,030	64.1	2,979
Carneval	60	TSP	208,984	2,027	64.6	2,850
Carneval	90	TSP	202,453	1,950	64.0	2,933
Mean	--	--	215,596	1,984	64.5	2,809
C.V. %	--	--	11.5	9.1	0.8	6.4
LSD .05	--	--	36,056	NS	NS	259

[1]NONE = no fertilizer; urea = 46-0-0; MAP = 11-52-0; TSP = 0-44-0.

Table 5. Plant stand, seed yield, bushel weight, and seed weight for Carneval and Trapper peas at five seeding rates at Dickinson in 1998.				
Treatment	Plant stand plants/acre	Seeds per pound #	Test weight lbs/bu	Seed yield bu/acre
Seeding Rate (SR)				
200,000 PLS/acre	154,289	3,136	63.5	30
250,000 PLS/acre	188,167	3,121	63.7	33
300,000 PLS/acre	217,555	3,229	63.8	31
350,000 PLS/acre	233,882	3,272	63.6	31
400,000 PLS/acre	234,698	3,260	63.8	32
LSD .05	25,538	NS[1]	NS	NS
Cultivar (C)				
Carneval	224,821	2,041	64.4	42
Trapper	186,616	4,366	63.0	21
LSD .05	16,152	116	0.4	2

Mean	205,718	3,204	63.7	31
SR X C	*	NS	NS	NS
[1]NS = not significant; * = significant at the $P < 0.05$ level.				

Table 6. Agronomic characteristics of six mustard cultivars at Dickinson in 1998.

Cultivar	Type	Days to flower d	Flower duration d	Seeds per pound #	Plant height in	Test weight lbs/bu	Seed yield lbs/ac	Gross returns $/acre
AC Pennant	Y	42	30	113,350	24	55.9	765	103.27
AC Vulcan	O	47	27	200,210	36	52.8	1,059	142.98
Forge	O	51	27	223,004	40	52.8	677	91.45
SA 92-75	Y	42	30	105,683	26	55.9	749	101.07
Tilney	Y	41	31	93,995	27	55.0	811	109.43
Viscount	Y	42	32	113,578	28	55.3	683	92.22
Mean	--	44	29	141,637	30	54.6	791	106.74
C.V. %	--	1	4.0	10.6	5.9	1.2	15.5	15.5
LSD .05	--	1	2	22,562	3	1.0	NS	NS

Table 7. Agronomic characteristics of twelve safflower cultivars at Dickinson in 1998.							
Variety	Days to flower d	Seeds per pound #	Plant height in	Oil %	Test weight lbs/bu	Seed yield lbs/ac	Returns $/acre
95B 7181	84	13,782	24	35.2	44.3	1,645	197.40
Centennial	87	14,087	26	38.9	41.0	1,692	203.06
Erlin	85	17,364	23	35.5	37.1	1,327	159.30
Finch	86	14,589	26	34.5	44.4	1,492	178.99
Montola 2000	86	16,147	22	36.3	38.0	1,477	177.23
Montola 2001	86	12,058	25	36.4	39.3	1,435	172.17
Morlin	88	18,358	25	36.0	40.0	1,479	177.44
S 317	86	14,209	27	36.8	38.3	1,769	212.30
S 518	87	14,399	25	35.6	37.0	1,990	238.77
S 541	87	14,316	24	38.7	40.0	1,793	215.13
Mean	86	14,931	25	36.4	39.9	1,610	193.18
C.V. %	0.7	4.4	4.2	1.7	0.8	7.1	7.1
LSD .05	1	956	2	0.9	0.5	165	19.83

Table 8. Agronomic characteristics of five flax cultivars at Beulah and Hannover in 1998.					
Variety	Seeds per Pound #	Plant Height in	Test Weight lbs/bu	Seed Yield bu/ac	Returns $/acre
Beulah					
Cathay	142,374	19	50.0	7.2	33.42
Flor	150,138	20	50.0	9.6	44.77
Neche	138,000	20	50.0	7.5	35.07
Omega	151,754	21	49.0	9.2	42.83
Pembina	158,624	21	50.0	8.8	40.85
Mean	148,178	39.38	49.8	8.5	39.38
C.V. %	11.7	11.8	--	11.8	11.8
LSD .05	NS	NS	--	NS	NS
Hannover					
Cathay	83,366	26	56.6	25.9	120.29
Flor	90,348	24	56.4	25.0	116.47
Neche	85,641	25	57.1	23.6	109.74

Omega	81,750	26	56.4	23.0	107.17
Pembina	85,738	25	56.6	27.6	128.20
Mean	85,368	25	56.6	25.0	116.37
C.V. %	5.3	3.8	0.8	16.0	16.0
LSD .05	NS	NS	NS	NS	NS

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