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ALTERNATIVE CROPS AND CROPPING SYSTEMS IN SOUTHWESTERN NORTH DAKOTA

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OBJECTIVES

1. Evaluate cereals, pulses, and alfalfa alone and/or in mixtures with one another for feed and forage in southwestern North Dakota.

2. Investigate several plant species as oilseed crops.

3. Explore weed control strategies among alternative crops.

SUMMARY

Crop production systems in southwestern North Dakota have mostly been limited to small grains. Producers have begun to expand cropping choices as a way to enhance the economics of crop production. Besides enhancing market opportunities, crop diversity can improve pest control, increase soil organic matter levels, and enhance the cycling of nutrients in the soil. In North Dakota, development of crambe, lentil, and pea point to the benefits which biological diversity in cropping systems can offer. Crambe is naturally resistant to many small grain pests and can be used to break small grain disease cycles in rotations, as can lentil and pea. The seed of these crops are highly valued when sold in certain markets. Both lentil and pea are legumes and can biologically-fix over 100 pounds of nitrogen per acre under ideal conditions.

This project is directed at quantifying the potential which several alternative crops have in southwestern North

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Dakota. The project encompasses adaptation trials of field pea, lentil, and other pulse crops; canola, mustard, and other oilseed crops; and cereal cultivars and cereal-pea mixtures developed primarily for forage. New methods of establishing alfalfa and other forages in the southwest are being evaluated, as are weed management strategies when growing these crops. This project is collecting and publishing information on the performance of cereal forage crops and alternative crops and crop management strategies in southwestern North Dakota.

This publication will be made available in alternative formats upon request.

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INTRODUCTION

Corn is a dependable feed crop in North Dakota. Conlon and Douglas (1957) reported that corn produced larger yields per acre than any other feed crop grown at the Dickinson Experiment Station between 1907-57. In summarizing earlier research, Conlon and Douglas (1953) concluded that a corn-wheat-oat rotation generated considerably greater returns than a fallow-wheat-oat rotation on diversified crop-livestock farm operations. The corn produced on the farm was marketed through livestock.

Successful southwestern livestock producers have continued to find that corn is a dependable and excellent forage (Nelson and Landblom, 1991). Corn is perhaps the most versatile cultivated forage grown in the southwest. Ensiled corn with small amounts of soybean meal and alfalfa hay can produce rapid and economical gains in cattle without digestive problems. Other silage crops like forage sorghum have been unable to match the yields produced by corn (Nelson and Landblom, 1991).

Corn grown as silage is an excellent forage crop, but it is deficient in certain essential amino acids. Soybean meal generally is added to correct the protein deficiencies (Goodrich and Meiske, 1976). Unfortunately, soybean is not adapted to local growing conditions in the southwest, so the soybean meal added to the feed ration is an off-farm cost to producers. Adaptation screening trials suggest that lupin, which could be substituted for soybean meal in livestock rations, may successfully be grown in western North Dakota (Carr et al., 1992, 1993, 1994).

An alternative to blending ensiled corn with soybean meal to increase protein content is to grow corn and soybean

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together. Soybean is not adapted to growing conditions in the southwest, however, and corn-soybean mixtures have performed poorly when grown (Carr, unpub. data). Other pulses may be adapted to growing conditions and might perform well if intercropped with cereal crops.

Research suggests that barley-pea and oat-pea mixtures can successfully be grown in the southwest for grain or forage (Carr et al., 1994). Little is known, however, on how to best manage barley-pea and oat-pea mixtures in a climate like that in the southwest. Several trials have been started at the Dickinson Research Extension Center to determine how barley-pea and oat-pea mixtures can be managed for optimal grain and/or forage production.

Barley and oat are popular feed crops in the southwest. Past work indicates that barley and oat produce less total digestible nutrients than corn grown for either grain or silage (Smith and Stoa, 1944; Wiidakas, 1967). However, barley and oat are sometimes preferred over corn by producers because of equipment constraints, crop rotation considerations, and weed control options. This project will compare several barley and oat cultivars, some of which have been developed for forage production, as haylage and hay crops.

Work by Meyer and others (Meyer et al., 1990; Meyer and Helm, 1994) supports clear seeding alfalfa in a no-till seedbed rather than establishing alfalfa with an oat companion crop. However, much of this work was conducted in eastern North Dakota. It is unknown if establishing alfalfa in a no-till seedbed is preferred over sowing alfalfa with oat in western North Dakota. This project will compare alfalfa yield and quality among contrasting establishment methods at Dickinson.

Canola, mustard, and other crops have been identified as promising oilseed crops adapted to growing conditions in the southwest (Carr et al., 1994). Adaptation trials involving these crops have been limited to only a few of the most common cultivars. To better determine the agronomic potential of these oilseed crops, this project will screen several Argentine and Polish canola cultivars, and several brown, oriental, and yellow mustard cultivars, to determine which cultivars are best adapted to southwest growing conditions.

Flax and lentil are adapted to growing conditions in the southwest, but weed problems can be encountered when growing these two crops. Both are poor competitors with weeds, particularly early in the growing season (Martin et al., 1976). Weed control problems encountered when growing these crops are an obstacle to their wider adoption by

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producers in the southwestern region of the state.

Limited work in the southwest suggests that harrowing may be effective in reducing stands of common lambsquarters, foxtail, kochia, pigweed, and other small seeded weeds in flax (Carr et al., 1994). More work is needed to determine how effective mechanical and other tools are in controlling weeds in flax and lentil, as well as in hard red spring wheat and other widely-grown crops in the southwest.

MATERIALS AND METHODS

Objective 1

Cultivar Adaptation Trials. Lupin, field pea, and lentil were evaluated in cultivar comparison trials at Dickinson. A corn cultivar trial also was conducted, as was a cool season and warm season forage trial, a forage barley and oat trial, and a cereal-pea cutting date trial. Seed of 7 lupin, 9 field pea, and 7 lentil cultivars were provided by the Carrington and North Central Research Extension Centers. Corn seed was solicited from private seed companies. Seed of the 7 entries in the cool season forage trial was provided by the North Central Research Extension Center, as was the seed of the 4 entries in the warm season forage trial. Seed of the 12 barley, oat, or cereal-pea mixtures in the forage barley and oat trial were obtained from several sources, as were the 10 entries in the cereal pea cutting date trial.

Cultural practices including tillage and seeding, fertilization, herbicide application, and harvesting followed currently acceptable agronomic procedure in implementing and maintaining cultivar comparison trials.

Cultivars were evaluated using a randomized complete block design with four replicates. Individual plot dimensions were 28 by 6 ft, except for corn plots, which were 50 by 6 ft. Variables measured on each plot depended on the trial. Days to flower, flower duration, days to maturity, lodging score, plant height, grain yield and test weight, and seed weight, were recorded for lupin, field pea, and lentil trials. In the corn hybrid trial, silage yield and moisture content were determined. Plant height, harvest moisture, hay yield, and quality were determined for entries in the cool season forage trial. Plant height, harvest moisture and hay yield were determined for the forage barley and oat trial, the cereal-pea cutting date trial, and the warm season forage trial.

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Alfalfa was established in no-till and conventionally-tilled environments in plots measuring 10 by 250 ft using a John Deere 750 no-till planter. Plots were arranged in a randomized complete block design with four replicates. Plant counts and hay yield were determined for each plot.

Data collected from each trial were analyzed by computer using a statistical software program.

Objective 2

Cultivar Adaptation Trials. Six mustard and nine canola varieties were evaluated in cultivar comparison trials at Dickinson. Seed of both crops was provided by the Langdon Research Center. Cultural practices including tillage and seeding, fertilization, herbicide application, and harvesting followed currently acceptable agronomic procedure in implementing and maintaining cultivar comparison trials.

Cultivars were evaluated using a randomized complete block design with four replicates. Individual plot dimensions were 28 by 6 ft. Variables measured on each plot included days to flower, flower duration, days to maturity, lodging score, plant height, grain yield, test weight, and seed weight. Seed oil content was determined by Jim Hanzel in the Plant Sciences Department at North Dakota State University located at Fargo.

Objective 3

Mechanical Weed Control Trial. A field experiment was conducted under dryland conditions. The experiment was arranged in a randomized complete block design in a split-plot arrangement with four replicates. Crop species comprised main plots and included flax, lentil, and hard red spring wheat.

Weed control treatments comprised subplots. These were oriented at right angles to main plots and included: (1) rotary hoeing at three to five days after seeding; (2) rotary hoeing at three to five days after seeding and again when plants were 2-5 in. tall; (3) harrowing with a spring tooth harrow at three to five days after seeding; (4) harrowing at three days after seeding and again when seedlings were 2-5 in tall; (5) rotary hoeing at three to five days after seeding plus herbicides; (6) harrowing at three to five days after seeding plus herbicides; and (7) herbicides alone. Herbicide treatments included a postemergent application of 0.25 lb a.i./ac Buctril for flax when rotary hoed or harrowed and 0.4 lb a.i./ac Poast plus 0.25 lb a.i./ac Buctril when not hoed or harrowed; a postemergent application

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of 0.38 lb a.i./ac Sencor for lentil when rotary hoed or harrowed and 0.4 lb a.i./ac Poast plus 0.38 lb a.i./ac Sencor when not hoed or harrowed; and a postemergent application of 0.25 lb a.i./ac Buctril for wheat when rotary hoed or harrowed and 0.9 lb a.i./ac Hoelon plus 0.25 lb a.i./ac Buctril when not hoed or harrowed. A check (no weed control) treatment was included in each replicate.

Variables measured on each plot included: plant population at establishment or approximately 2 days after the last tillage pass, whichever was later, dry matter production of grass and broadleaf weeds, and seed yield of each crop. Weed control within each plot was visually rated as percent control compared to the check subplot.

Data were analyzed as a split-plot by computer using a statistical software program. Subplots also were analyzed individually.

Poast/Treflan Comparison in Flax Trial. Flax was sown at two dates in plots in which no herbicide was applied; in plots in which 1 pt of Treflan per acre was applied prior to sowing and 1 pt Buctril after flax plants had emerged; and in plots in which 2 pt Poast plus 2 pt Scoil plus 1 pt Buctril were applied after flax had emerged.

Plots were arranged in a randomized complete block design in a split-plot arrangement. Planting dates comprised the main plots and weed control treatments comprised subplots. Variables measured on each plot included: plant stand; visual weed control; weed biomass; and flax seed yield.

Data were analyzed as a split-plot by computer using a statistical software program.

RESULTS

Objective 1

Corn

Average yield of corn silage was 5.5 tons of dry matter per acre among the 10 commercial hybrids and one public variety evaluated in 1995. Significant differences were observed among the entries for silage yield; highest yields were produced by Dekalb DK 385, Cenex 555 and 289, Pioneer 3921and 3905. Birds destroyed grain before it

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could be harvested and the grain yield determined.

Cool Season Forage Trial

Azure barley produced significantly more hay than oat, triticale, oat- and triticale-pea mixtures in a recropped environment. Hay quality (crude protein content, acid- and neutral detergent fiber content) tended to be less for Azure barley than the other entries, suggesting a trade-off between the higher yield with the lower crude protein content of the barley. However, signficant differences were not observed between entries for any hay quality parameter.

Hay yield was significantly less for Frank triticale and Whitestone oat when it was intercropped with Trapper pea compared to growing the cereal alone. We speculate that the low rate at which the cereal component was sown in intercrops may explain the lower yield of the mixtures; Carr and others (1994) suggested that monocropped yield levels could be maintained by mixtures if the cereal component was sown at or above the sole-crop rate. Hay yield sometimes was reduced if the cereal was sown at half the sole-crop rate. Crude protein content of oat-pea mixtures tended to be higher (16%) than that of sole oat (14%), although a significant difference was not detected.

Forage Barley and Oat Trial

An average of 3.4 tons of hay was produced by the barley, oat, and oat-pea mixtures in the trial. Haybet barley, a forage-type barley recommended for irrigated environments in Montana, produced the most hay, although B 7518 and Stark barley produced comparable amounts. Lowest yield was produced by a mixture of Dumont oat and Trapper pea when each crop wassown at half the sole-crop rate. Sowing Dumont oat at the sole-crop rate with pea at 3/2 of the sole-crop rate produced comparable amounts of hay to that produced by B 7518 and Stark barley.

Data collected in 1995 suggest that Stark barley can produce as much or more hay than other barley and oat cultivars developed and grown for forage in the southwest, including Mammoth oat and Horsford barley. However, this trial must be continued to determine if yield trends observed among the entries in 1995 are consistent across more years. Hay quality must also be determined before any conclusions about the suitability of the barley and oat cultivars, and oat-pea mixtures, included in this trial for hay production can be made for the southwest.

Cereal-Pea Cutting Date Trial

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Sowing Dumont oat alone, or sowing both Dumont oat and Trapper pea at 3/2 the sole-crop rate in a mixture, produced as much or more hay than any other treatment in 1995. Hay yield averaged 2.7 tons per acre across all treatments when cut on July 18 (app. milk stage); yield averaged 3.2 tons per acre if cutting was delayed until July 24 (early soft dough). This trial will be continued and expanded in 1996 to include 4 cutting dates, corresponding to cereal early boot, milky kernel, soft dough kernel, and hard dough kernel growth stages. Hay quality data will also be generated for 1995 and 1996 samples.

Warm Season Forage Trial

Average yield for the entries harvested for hay in this trial was 3.6 tons per acre; data was not collected for a hybrid pearl millet entry because of poor stand establishment. German millet and a Sorghum x Sudan cross produced the most hay, with yields over 4 tons per acre. Siberian millet and Piper Sudangrass produced around 3 tons of hay per acre.

Alfalfa Establishment Method Trial

Clear seeding alfalfa in a no-till seedbed produced less hay than sowing alfalfa in a conventionally-prepared seedbed with an oat nurse crop in 1995 at the P=0.053 level of signficance. Differences in alfalfa yield between the two establishment methods were not observed between plots established in 1994; however, average alfalfa hay yield tended to be greater for the clear seeding method than the conventional + companion crop method for both the first cutting (P=0.28) and the second cutting

(P=0.56). More subsamples will be collected in 1996 to improve our ability to detect differences between treatments at the P<0.05 level.

Field Pea

The field pea trial was expanded from six varieties in 1994 to nine varieties in 1995. Average grain yield for the nine pea varieties was over 2200 lbs per acre in a field where barley was sown in 1994. Assuming a feed pea price of $0.06, average gross returns would have been $132. Gross returns have been reported to be more than twice as

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much in 1995 by some producers selling peas in higher-valued markets. No problems were encountered in establishing pea. Carneval and Majoret were rated as the easiest varieties to harvest (refer to lodging score). Seed yield across pea varieties evaluated in a continuously-cropped environment at Dickinson has averaged well over 1500 lbs per acre in the last three years the trial has been conducted.

Lentil

Lentil yield ranged from 1395 lbs per acre for Spanish Brown to 2108 lbs per acre for CDC Richlea in 1995. Assuming a contract price of $0.15 per pound, gross returns for CDC Richlea would have been $316 per acre.

Crimson, a variety of lentil developed by USDA-ARS scientists located at Pullman, Washington, for semiarid regions, continued to yield well. Of the varieties evaluated over the past three years, Crimson has consistently been among the highest yielding. It tends to mature earlier and be shorter than the dominant varieties grown.

Lentil is short compared to wheat and other crops that most growers are familiar with. Distance from the top of plants to the soil surface averaged only 12 inches for the lentil varieties evaluated at Dickinson in 1995, and 11 inches in 1994. However, we observed on farms in Golden Valley county that rolling lentils after they were established increased lentil height in 1995. Care should be taken to roll plants when they are somewhat wilted and mechanical injury to the plants can be minimized. Even with rolling, lentil production seems best suited to level fields that are free of rocks. Reduced- and no-till seedbeds are probably better suited than conventionally-tilled seedbeds for lentil, since the plants will be supported by standing stubble and may stand more upright.

Lupin

Grain yield averaged only 645 lbs per acre among the lupin varieties evaluated at Dickinson in 1995. This low yield does not reflect problems in establishing the lupin trial, but rather a disease problem that dessimated the lupin stand. Similar problems were encountered in 1994. The high variability in yield (indicated by the high CV[%]) across plots for a single variety has made yield comparisons between varieties difficult over the past three years, as well as drawing conclusions about the adaptability of lupin in low- and medium- pH soils in the southwest.

Objective 2

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Mustard

Yield across entries in the mustard trial averaged around 2000 lbs seed per acre in 1995. Yield ranged from 1700 to 2500 lbs seed per acre; oriental Cutlass was the highest yielding cultivar (2491 lbs per acre) and yellow Ochre the lowest (1695 lbs per acre). Assuming a contract price for yellow mustard seed of $0.13 per pound, gross returns from Ochre would have been $220 per acre.

Canola

Seed yield across the canola varieties was comparable to yield across the mustard varieties evaluated in 1995; canola yield ranged from 1400 lbs seed per acre for Tobin to 2500 lbs seed per acre for Hyola 401. Assuming a contract price of $0.11 per pound, gross returns from Hyola 401 would have been $275 per acre.

These trials will be continued, and possibly expanded, and a crambe trial begun, in 1996.

Objective 3

Mechanical Weed Control Trial

Most effective control of weeds resulted when herbicides were used alone or in combination with either the harrow or rotary hoe. Without herbicides, single or multiple cultivations using a harrow or rotary hoe generally failed to control weeds as effectively as any control treatment including herbicides. Both the harrow and rotary hoe generally reduced weeds compared to the check (no control) treatment across years, but not at a level that we feel most producers would be willing to accept.

In some instances, seed yield was comparable between plots in which weeds were mechanically controlled and plots in which only herbicides were used to control weeds, regardless of which crop was grown. Greatest amounts of seed sometimes were produced when a preemergent mechanical cultivation was combined with a postemergent application of herbicide, though yield generally was not significantly greater than that for the treatment including only herbicides. One exception occurred with flax in 1994, where yield was significantly greater for the harrow + herbicide

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treatment than the herbicide treatment.

Crop stand tended to be reduced by both pre- and postemergent cultivation with either the harrow or rotary hoe, although there were several exceptions. Of the crops evaluated, flax stand was reduced most dramatically.

Poast/Treflan Comparison Trial in Flax

Treflan and Poast both controlled grassy weeds compared to not applying any herbicide for grassy weed control; however, differences in weed production were not detected between herbicide treatments. Flax seed yield was reduced when herbicides were not used. Flax yield was less in plots where Poast was applied than in plots where Treflan was applied in 1994, and more (P=0.099) in 1995. Stand establishment problems resulted from soil crusting probems in 1994 and may partially explain why plots in which Poast was applied also contained less flax seed than plots in which Treflan was applied (flax seed yield CV%==42). Stand establishment problems were not encountered in 1995 (flax seed yield CV%=12.7).

We observed no reduction in flax plant stand in plots where Treflan was applied rather than Poast. However, flax plants were stunted and lighter in color in plots where Treflan was applied until flowering.

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1995 HYBRID CORN TRIAL - RECROP - DICKINSON

Brand	Hybrid	RM days	Harvest Moisture %	Silage Yield					
				70%	DM basis				
				Moisture	1995	1994	1993	3-Year	2-Year
				tons/ac					

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Cenex	176	80	57	17.7	5.3	--	--	--	--
Cenex	289	90	63	19.7	5.9	--	--	--	--
Cenex	555	115	71	20.0	6.0	--	--	--	--
Dekalb	DK 343	84	56	18.2	5.5	3.6	3.1	4.1	4.6
Dekalb	DK 385	88	59	21.5	6.5	--	--	--	--
Public	MN-13	Open[1]	55	16.3	4.9	--	--	--	--
Pioneer	3905	87	54	19.2	5.8	4.1	--	--	5.0
Pioneer	3921	86	57	19.7	5.9	3.1	--	--	4.5
Pioneer	3951	80	56	15.3	4.6	--	--	--	--
Pioneer	3963	79	55	19.0	5.7	3.7	3.3	4.2	4.7
Pioneer	3984	75	54	13.7	4.1	--	--	--	--
Mean			58	18.2	5.5				
CV(%)			6.6	10.9	10.9				
LSD .05			5.5	2.9	0.9				

[1]Open = open pollinated
Previous crop: Black lentil (plow down); Soil test results: 107 lbs N, 18 ppm P; applied 225 lbs urea per acre; planted at 22,000 seed per acre on May 22; Applied 0.67 oz Accent + 0.60 lbs Atrazine + 1.5 pt Scoil per acre on June 16; Harvested on September 20.

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COOL SEASON ANNUAL FORAGES - RECROP - DICKINSON

Crop	Variety	Cereal Height inches	Harvest Moisture %	Hay Yield			
				12%	DM basis		
				Moisture	1995	1994	2-Year
				tons/ac			
barley	Azure	86	66	4.9	4.4	--	--
triticale	Frank	98	67	3.7	3.2	--	--
triticale/pea	Frank/Trapper	91	73	3.0	2.7	--	--
triticale/pea	'Sprint'	92	74	3.3	2.9	--	--
oat/pea	'Tripper'	113	71	3.7	3.2	--	--
oat	Whitestone	84	73	3.8	3.3	--	--
oat/pea	Whitestone/Trapper	79	77	3.0	2.6	--	--
Mean		91.8	72	3.6	3.2		
CV(%)		4.6	2.9	11.0	11.0		
LSD.05		6.3	3.1	0.6	0.5		

Previous crop: Black lentil (plow down); Soil test results: 66 lbs N, 17 ppm P; no fertilizer applied; planted at 100 lbs (Azure), 75 lbs (Frank), 95 lbs (Frank [35] + Trapper [60]), 65 lbs (Whitestone), 95 lbs (Whitestone [35] + Trapper [60]), and 120 lbs (Tripper and Sprint) seed per acre on May 17; No herbicide applied; Harvested on July 19.

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COOL SEASON ANNUAL FORAGES - RECROP - DICKINSON					
Crop	Variety	Crude Protein	Acid Detergent Fiber	Neutral Detergent Fiber	Relative Feed Value
		%			
barley	Azure	14.5	32.5	52.5	113.5
triticale	Frank	16.0	33.5	54.0	108.6
triticale/pea	Frank/Trapper	16.5	37.0	54.5	103.6
triticale/pea	'Sprint'	14.5	37.0	56.5	98.8
oat/pea	'Tripper'	15.5	42.5	60.5	86.6
oat	Whitestone	14.0	37.0	58.5	95.3
oat/pea	Whitestone/Trapper	16.0	37.0	55.0	101.3
Mean		15.3	36.6	55.9	101.1
CV(%)		5.9	8.0	5.0	8.2
LSD.05		NS	NS	NS	NS

Previous crop: Black lentil (plow down); Soil test results: 66 lbs N, 17 ppm P; no fertilizer applied; planted at 100 lbs (Azure), 75 lbs (Frank), 95 lbs (Frank [35] + Trapper [60]), 65 lbs (Whitestone), 95 lbs (Whitestone [35] + Trapper [60]), and 120 lbs (Tripper and Sprint) seed per acre on May 17; No herbicide applied; Harvested on July 19.

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FORAGE BARLEY AND OAT - RECROP - DICKINSON

Crop	Variety	Height inches	Harvest Moisture %	Hay Yield					
				12% Moisture	DM basis				
					1995	1994	1993	3-Year	2-Year
				tons/ac					
barley	B 7518	68	69	4.3	3.8	--	--	--	--
oat	Bay	81	72	3.8	3.3	--	--	--	--
barley	Chopper	86	64	3.8	3.4	--	--	--	--
oat	Dumont	92	73	3.6	3.2	2.4	2.9	2.8	2.8
oat/pea	Dumont/Trapper[1]	85	75	3.8	3.4	2.5	3.3	3.1	3.0
oat/pea	Dumont/Trapper[2]	97	74	3.3	2.9	2.2	2.9	2.7	2.6
barley	Haybet	74	64	4.5	4.0	--	--	--	--
barley	Horsford	83	67	3.6	3.2	4.6	2.7	3.5	3.9
barley	I 92-615-2	76	62	3.1	2.7	--	--	--	--
oat	Mammoth	102	73	3.9	3.4	--	--	--	--
barley	Stark	87	65	4.3	3.7	--	--	--	--
barley	Weal	75	65	3.7	3.3	--	--	--	--

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Mean		84	69	3.8	3.4				
CV(%)		5.0	2.6	9.7	9.7				
LSD.05		6.0	2.6	0.5	0.5				

Previous crop: Black lentil (plow down); Soil test results: 66 lbs N, 17 ppm P; no fertilizer applied; planted at 800,000 Pure Live Seed (PLS) per acre on May 17, except for oat-pea mixtures which were sown at 750,000 oat plus 487,500 pea PLS per acre ([1]) and 375,000 oat plus 162,500 PLS per acre ([2]); No herbicide applied; Harvested on July 19.

CEREAL/PEA CUTTING DATE TRIAL - RECROP - DICKINSON

Crop	Variety	Seeding Rate		Height		Harvest Moisture	
		Cereal	Pea	Cereal	Pea	1 cut	2 cut
		seeds/acre		inches		%	
oat/pea	'Tripper'			31	36	75	73
oat	Dumont	750,000	0	37	--	73	72
barley	Horsford	750,000	0	30	--	77	68
triticale/pea	'Sprint'	[1]	[1]	44	32	70	70
barley/pea	Horsford/Trapper	1,125,000	487,000	28	20	76	71
barley/pea	Horsford/Trapper	375,000	162,500	28	23	76	71
barley/pea	Horsford/Trapper	750,000	325,000	29	24	76	73
oat/pea	Dumont/Trapper	1,125,000	487,000	35	33	74	73

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oat/pea	Dumont/Trapper	375,000	162,500	36	34	75	75
oat/pea	Dumont/Trapper	750,000	325,000	36	30	73	76
Mean				33.7	29.3	74.5	72.3
CV(%)				4.6	13.4	2.0	2.7

Variety	Seeding Rate		Harvested Yield		Dry Weight		
	Cereal	Pea	1 cut	2 cut	1 cut	2 cut	1-2
	seeds/acre		tons/acre				
Tripper			11.0	12.5	2.8 b	3.3 b	0.5
Dumont	750,000	0	11.3	12.5	3.0 ab	3.5 a	0.5
Horsford	750,000	0	9.8	9.2	2.2 c	2.9 c	0.7
'Sprint'	[1]	[1]	10.4	10.5	3.1 ab	3.1 b	0.0
Horsford/Trapper	1,125,000	487,00	9.7	11.0	2.3 c	3.2 b	0.9
Horsford/Trapper	375,000	162,50	8.6	10.8	2.1 c	3.1 b	1.0
Horsford/Trapper	750,000	325,00	9.5	11.0	2.2 c	3.0 b	0.8
Dumont/Trapper	1,125,000	487,00	12.2	12.7	3.2 a	3.4 ab	0.2
Dumont/Trapper	375,000	162,50	11.5	12.5	2.8 b	3.2 b	0.4
Dumont/Trapper	750,000	325,00	11.6	12.9	3.1 ab	3.1 b	0.0

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Mean			10.6	11.6	2.7	3.2	
CV(%)			8.4	6.5	10.5	9.4	

Previous crop: Black lentil (plow down); Soil test results: 66 lbs N, 17 ppm P; no fertilizer applied; planted at 800,000 Pure Live Seed per acre, or 80 lbs oat and 40 lbs pea for 'Sprint' [1] on May 17; No herbicide applied;Harvested first cutting on July 14 (Horsford) and July 18 (other entries); second cutting made on July 21.

WARM SEASON ANNUAL FORAGES - RECROP - DICKINSON

Crop	Variety	Days to Heading days	Harvest Moisture %	Hay Yield					
				12% Moisture	DM basis				
					1995	1994	1992	3-Year	2-Year
				tons/ac					
Millet	German	86	60	4.9	4.3	--	4.7	--	4.5
Sudangrass	Piper	79	57	3.3	2.9	--	--	--	--
Millet	Siberian	79	54	3.2	2.9	--	4.3	--	3.6
Sorghum x Sudan	Sudax	86	64	4.7	4.2	--	--	--	--
Mean			0.6	4.0	3.6				

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CV(%)			3.2	10.9	10.9				
LSD.05			3	0.7	0.6				

Previous crop: Black lentil (plow down); Soil test results: 43 lbs N, 17 ppm P; no fertilizer applied; planted at 20 lbs (millets) and 25 lbs (Sudangrass and Sorghum x Sudan cross) on May 22; Applied 0.75 pt Buctril per acre on June 17; Harvested Sudangrass and Siberian millet on August 9 and other entries on August 16.

ESTABLISHMENT METHOD TRIAL - ALFALFA - DICKINSON

Year	Establishment method	Plant Count		Hay Yield (0% moisture)	
		oat	alfalfa	1st cut	2nd cut
		plants/acre		tons/acre	
1	Clear seeded into notill	--	1,303,315	1.8	2.5
	With an oat nurse crop	--	1,843,459	1.2	2.1
Mean		--	1,573,387	1.5	2.3
CV(%)		--	18.5	39.8	32.3
LSD.05		--	NS	NS	NS
2	Clear seeded into notill	--	1,658,765	2.7	--

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	with an oat nurse crop	566,280	1,901,830	4.8	--
Mean		--	1,780,297	3.7	--
CV(%)		--	27.4	25.6	--
LSD.05		--	NS	NS	--

Previous crop: barley; Soil test results: 47 lbs N, 9 ppm P; Applied 100 lbs 0-45-0; Planted alfalfa at 10 lbs Live Seed/acre on April 24 with a John Deere 750 drill; Harvested on June 20 (1st cut, year 1 alfalfa), July 24 (2nd cut, 1st year), and July 28 (1st cut, year 2 alfalfa).

DRYLAND FIELD PEA - RECROP - DICKINSON

Variety	Maturity	Cotyledon Color	Vine Length	Days to Flower	Flower Duration	Days to Maturity	Lodging Score[1]
				days			
Carneval	Medium	Yellow	Short-M	48	19	83	3
Century	Late	Yellow	Long	50	25	88	5
Columbian	Early	Green	Long	35	24	82	8
Express	Medium	Yellow	Short	47	24	83	6
Majoret	Early	Yellow	Short-M	46	16	83	3
MIKO	Medium	Yellow	Short	49	13	84	5
Profi	Early	Yellow	Short	46	18	83	5
Radley	Early	Green	Medium	45	17	83	8

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Trapper	Late	Yellow	Long	50	25	87	5
Mean				46	20	84	5.2
CV(%)				2.8	7.1	1.6	11.4
LSD.05				1.8	2.1	1.9	0.9

Variety	1995			Grain Yield				
	Seeds lb	Test weight lbs/bu	Height inches				----- Averages-----	
				1995	1994	1992	3-Year	2-Year
				lbs/ac				
Carneval	1879	63.2	23	2816.8	--	--	--	--
Century	1994	63.0	25	2719.4	1678.1	2152.2	2183.2	2198.8
Columbian	1904	61.7	9	1273.5	--	--	--	--
Express	1959	62.1	19	2586.4	1611.1	--	--	2098.8
Majoret	1763	63.5	21	2619.7	--	--	--	--
Miko	1596	61.9	20	2489.1	--	--	--	--
Profi	1660	62.2	17	2646.8	1699.0	--	--	2172.9
Radley	2225	63.2	12	1607.6	--	--	--	--

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Trapper	3471	62.8	23	2214.8	1429.8	3208.0	2284.2	1822.3
Mean	2015	62.6	18.5	2237.7				
CV(%)	4.3	0.7	11.3	9.7				
LSD.05	124.6	0.6	3.0	282				

[1]0 = no lodging; 9 = completely flat

Previous crop: Barley; Soil test results: 64 lbs N, 17 ppm P - no fertilizer applied (but pea seed inoculated with N-fixing bacteria); Applied 2.75 pt Sonalan per acre on April 24 (seed was used for experimental purposes none was sold or fed to livestock); Planted at 300,000 Pure Live Seed on May 15; Harvested on August 14 (except for Century and Trapper pea, which were harvested on August 18).

DRYLAND LENTIL - RECROP - DICKINSON

Variety	Type	Days to Flower	Length of Flower Period	Days to Harvest	Height inches
		days			
Brewer	Grain	42	33	101	10
CDC Richlea	Grain	49	27	100	12
Crimson	Grain	51	22	94	10
Eston	Grain	46	27	100	11
Indian Head	Forage	56	28	100	15

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Laird	Grain	53	25	104	13
Spanish Brown	Grain	44	29	100	8
Mean		48.8	27.2	100	11.6
CV(%)		1.4	6.1	1.6	10
LSD.05		1.0	2.5	2.3	1.7

Variety			Grain Yield				
	Seeds lb	Test weight lbs/bu				----- Averages-----	
			1995	1994	1993	3-Year	2-Year
			lbs/ac				
Brewer	7,369	59.5	1448.0	652.0	2503.0	1534.3	1050.0
CDC Richlea	9,261	61.4	2108.2	846.0	--	--	1477.1
Crimson	12,426	63.1	2009.2	1106.0	3255.0	2123.4	1557.6
Eston	13,512	63.1	1826.6	701.0	2647.0	1724.9	1263.8
Indian Head	20,630	64.8	1657.5	--	--	--	--
Laird	6,782	58.9	1693.2	545.0	--	--	1119.1
Spanish Brown	11,786	63.2	1395.0	784.0	--	--	1089.5

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Mean	11,681	62.0	1734.0				
CV(%)	5.1	1.1	11.1				
LSD.05	886	1.0	285.8				

Previous crop: Barley; Soil test results: 64 lbs N, 17 ppm P - no fertilizer applied (but pea seed inoculated N-fixing bacteria); Applied 2.75 pt Sonalan per acre on April 24 (seed was used for experimental purposes none was sold or fed to livestock); Planted on May 15; Harvested: August 17 (Crimson); August 23 (CDC Richlea, Eston, Indian Head, and Spanish Brown); August 24 (Brewer); August 27 (Laird).

DRYLAND LUPIN - RECROP - DICKINSON

Variety	Type	Days to Flower	Length of Flower Period	Days to Harvest	Height inches
		days			
Gungurru	Blue	45	36	94	13
Juno	Yellow	44	34	94	17
Lupro 101	White	45	36	104	18
Lupro 208	White	48	33	110	18
Merrit	Blue	44	35	89	11
Primorski	White	43	38	105	22
Progress	White	45	36	107	21

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Mean		46.6	35.6	100.3	17.2
CV(%)		2.1	3.8	4.9	7.5
LSD.05		1.4	2.0	7.3	1.9

Variety			Grain Yield				
	Seeds lb	Test weight lbs/bu				----- Averages-----	
			1995	1994	1993	3-Year	2-Year
			lbs/ac				
Gungurru	--	55.7	841.1	1012.6	1756.8	1203.5	926.9
Juno	--	55.6	271.0	596.7	1438.1	768.6	433.9
Lupro 101	--	52.2	741.1	--	--	--	--
Lupro 208	--	51.6	379.4	--	--	--	--
Merrit	--	55.4	675.7	1150.2	1449.3	1091.7	913.0
Primorski	--	56.5	897.3	1415.5	1455.8	1256.2	1156.4
Progress	--	55.4	711.8	831.8	2007.0	1183.5	771.8
Mean		54.6	645.4				
CV(%)		10.3	38.6				
LSD.05		NS	NS				

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Previous crop: Barley; Soil test results: 64 lbs N, 17 ppm P - no fertilizer applied (but pea seed inoculated with N-fixing bacteria); Applied 2.75 pt Sonalan per acre on April 24 (seed was used for experimental purposes only; none was sold or fed to livestock); Planted at 250,000 Pure Live Seed on May 15; Applied 6 oz Asana XL per acre on June 5; Harvested from 89 to 110 days after planting, depending on the variety sown.

DRYLAND MUSTARD - GREEN FALLOW - DICKINSON

Type	Variety	Days to Flower	Length of Flower Period	Days to Harvest	Height inches	Lodging Score[1]
Brown	Common	41	28	98	38	2
Oriental	Cutlass	40	28	100	37	3
Yellow	Gisilba	39	28	98	34	2
Oriental	Lethbridge 22A	40	30	99	39	4
Yellow	Ochre	40	29	98	40	3
Yellow	Tilney	40	28	98	40	2
Mean		40.0	28.5	98.5	38.0	
CV(%)		1.2	2.8	1.5	4.8	
LSD.05		0.7	1.2	2.3	2.6	

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Type	Variety	Seeds lb	Test Weight lbs/bu				Average
				Oil %	1995	1992	2-Year
					-- lbs/ac		
Brown	Common	176,2066	50.1	38.3	2095.1	1568.0	1831.6
Oriental	Cutlass	143,844	51.0	40.8	2491.3	1814.0	2152.7
Yellow	Gisilba	85,189	53.4	30.0	2222.2	--	--
Oriental	Lethbridge 22A	149,601	50.6	39.5	1800.3		
Yellow	Ochre	84,971	53.4	30.1	1695.3	--	--
Yellow	Tilney	83,881	53.8	28.7	2035.2	1496.0	1765.6
Mean		98,175	52.1	--	2056.6		
CV(%)		7	2.5	--	9.7		
LSD.05		12,813	2	--	300.0		

[1]0 = no lodging; 5 = completely flat

Previous crop: Black lentil (burn down); Soil test results: 154 lbs N, 25 ppm P - applied 20 lbs urea per acre; Applied 1 pt Treflan per acre on May 12 and incorporated; planted at 8 lbs (Brown and Oriental) and 15 lbs (Yellow) Pure Live Seed per acre on May 12; Applied 6 oz Asana XL on June 5; Harvested at 98 to 100 days following planting, depending on the variety.

DRYLAND CANOLA - GREEN FALLOW - DICKINSON

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Variety	Stand %	Days to Flower	Length of Flower	Days to to Maturity	Height inches	Lodging Score[1]
		days				
Crusher	95	47	31	105	39	1
Cyclone	92	35	43	109	37	2
Hyola 401 401	97	42	23	101	30	2
Hysun 110 110	97	37	24	87	29	3
Legend	100	45	22	101	37	3
OAC Springfield	96	43	22	102	34	3
Reward	87	36	25	87	27	4
Tobin	85	36	26	87	29	3
Trojan	85	46	32	106	39	2
Mean	92.9	40.9	27.5	98.4	33.6	
CV(%)	4.9	13.6	20.1	2.1	5.8	
LSD.05	6.6	8.1	8.1	3.1	2.9	

		Grain Yield	
			Average

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Variety	Seeds lb	Test Weight lbs/bu	Oil %	1995	1992	2-Year
				lbs/ac		
Crusher	156,703	51.5	41.6	1834.1	--	--
Cyclone	154,265	49.2	40.0	1782.7	--	--
Hyola 401	118,904	52.5	41.8	2506.4	--	--
Hysun 110	169,578	51.8	39.5	1772.2	--	--
Legend	147,848	51.0	41.2	1907.5	1218.0	1562.8
OAC Springfield	117,879	51.2	42.3	2081.1	--	--
Reward	190,322	50.8	41.8	1500.1	--	--
Tobin	194,795	50.8	39.6	1392.0	1290.0	1341.0
Trojan	144,620	49.8	41.5	1597.6	--	--
Mean	154,990	50.9	--	1819.3		
CV(%)	7.2	1.8	--	11.6		
LSD.05	16,309	1.3	--	309.1		

[1]0 = no lodging; 5 = completely flat

Previous crop: Black lentil (burn down); Soil test results: 154 lbs N, 25 ppm P - applied 20 lbs urea per acre; Applied 1 pt Treflan per acre on May 12 and incorporated; planted at 21 Pure Live Seed per square foot on May 12; Applied 6 oz Asana XL on June 5; Harvested at 87 to 106 days following planting, depending on the variety.

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MECHANICAL WEED CONTROL - FLAX - DICKINSON						
Treatment	Plant Stand			% of Check		
	1993	1994	1995	1993	1994	1995
	plants/acre			%		
Check (no control)	386,483	3,697,529	1,300,301			
Harrow + Herbicide	793,201	2,691,265	757,965	205	73	61
Herbicide	726,426	3,293,227	945,822	188	89	75
Harrow x 1	505,868	3,273,624	860,878	131	89	66
Harrow x 2	285,306	2,830,116	646,884	74	77	52
Rotary hoe + Herbicide	475,515	2,491,973	771,850	123	67	60
Rotary hoe x 1	754,755	2,496,873	952,357	195	68	75
Rotary hoe x 2	400,647	1,966,788	1,145,115	104	53	67
Mean	541,026	2,484,107	910,792			
CV(%)	47.2	17.1	21.9			
LSD.05	375,400	623,806	291,114			

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MECHANICAL WEED CONTROL - FLAX - DICKINSON

Treatment	Weed Biomass			Flax Seed Yield		
	1993	1994	1995	1993	1994	1995
	lbs/acre			bu/acre		
Check (no control)	4065.1	2112.1	4032.6	5.5	9.6	19.1
Harrow + Herbicide	3209.3	283.2	1393.1	10.9	21.2	26.9
Herbicide	2923.9	159.9	904.6	12.9	15.0	32.2
Harrow x 1	4012.0	1318.5	2806.5	7.5	16.6	25.3
Harrow x 2	4869.4	1352.8	2297.6	9.3	17.8	25.9
Rotary hoe + Herbicide	2635.4	280.3	1377.3	11.2	19.7	27.3
Rotary hoe x 1	3179.8	1735.9	2526.0	12.1	13.1	26.9
Rotary hoe x 2	2975.3	1281.5	3175.4	12.0	16.8	24.6
Mean	3,483.8	1,065.5	2385.1	10.4	16.2	27.1
CV(%)	37.6	40.3	72.0	23.1	21.7	26.7
LSD.05	NS	681.8	NS	3.5	5.2	NS

Previous Crop: Black lentil (burn down) Planting Date: May 3 Harvest Date: August 21

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MECHANICAL WEED CONTROL - LENTIL - DICKINSON

Treatment	Plant Stand			% of Check		
	1993	1994	1995	1993	1994	1995
	plants/acre			%		
Check (no control)	619,182	310,374	374,082			
Harrow + Herbicide	509,915	305,473	372,448	82	98	100
Herbicide	625,252	330,793	267,901	101	107	72
Harrow x 1	590,854	249,116	422,271	95	80	113
Harrow x 2	588,830	239,314	384,700	95	77	103
Rotary hoe + Herbicide	540,267	248,299	402,669	87	80	108
Rotary hoe x 1	607,041	204,193	384,700	98	66	103
Rotary hoe x 2	524,079	189,491	440,240	85	61	118
Mean	575,677	259,632	910,792			
CV(%)	13.3	20.3	21.9			
LSD.05	112,427	77,386	291,114			

MECHANICAL WEED CONTROL - LENTIL - DICKINSON

	Weed Biomass	Lentil Seed Yield

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Treatment	1993	1994	1995	1993	1994	1995
	lbs/acre			bu/acre		
Check (no control)	4904.0	5274.6	4423.0	6.9	1.0	9.7
Harrow + Herbicide	1476.8	1063.3	1215.6	9.3	13.4	23.4
Herbicide	2215.9	1367.2	2062.0	14.7	9.5	16.9
Harrow x 1	4566.3	3546.5	3999.0	8.0	1.8	9.7
Harrow x 2	1352.2	3304.0	4366.8	9.7	2.8	9.0
Rotary hoe + Herbicide	1195.2	1074.4	946.9	11.9	12.8	24.0
Rotary hoe x 1	1900.2	3469.6	4157.2	10.9	2.6	11.8
Rotary hoe x 2	1915.1	4765.4	4694.2	10.7	3.8	8.2
Mean	2,440.7	2,983.1	3233.1	10.3	6.0	15.4
CV(%)	45.6	27.5	42.4	24.2	65.5	30.5
LSD.05	1741.0	1353.5	2014.7	3.6	5.7	6.9

Previous Crop: Black lentil (burn down)
Planting Date: May 3
Harvest Date: August 21

MECHANICAL WEED CONTROL - HRSW - DICKINSON

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Treatment	Plant Stand			% of Check		
	1993	1994	1995	1993	1994	1995
	plants/acre			%		
Check (no control)	--	758,782	420,638	--		
Harrow + Herbicide	--	640,350	345,495	--	84	82
Herbicide	--	659,952	338,144	--	87	80
Harrow x 1	--	624,830	373,265	--	82	89
Harrow x 2	--	664,852	319,358	--	88	76
Rotary hoe + Herbicide	--	618,296	323,442	--	81	77
Rotary hoe x 1	--	603,594	402,669	--	80	96
Rotary hoe x 2	--	588,076	329,976	--	78	78
Mean		644,842	366,186			
CV(%)		10.4	12.1			
LSD.05		98,647	64,512			

MECHANICAL WEED CONTROL - HRSW - DICKINSON

Treatment	Weed Biomass			Wheat Seed Yield		
	1993	1994	1995	1993	1994	1995

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	lbs/acre			bu/acre		
Check (no control)	--	3084.7	1180.1	--	17.2	53.7
Harrow + Herbicide	--	670.6	374.6	--	29.9	55.4
Herbicide	--	244.8	521.9	--	23.4	53.8
Harrow x 1	--	1716.4	929.5	--	17.6	50.6
Harrow x 2	--	1660.8	577.4	--	24.5	57.4
Rotary hoe + Herbicide	--	329.6	431.5	--	30.1	56.6
Rotary hoe x 1	--	1486.1	645.3	--	22.2	50.4
Rotary hoe x 2	--	1511.4	979.5	--	27.3	50.7
Mean		1,338.1	638.8		24.0	53.8
CV(%)		77.2	87.8		22.2	8.5
LSD.05		1518.3	NS		7.8	NS

Previous Crop: Black lentil (burn down)
Planting Date: May 3
Harvest Date: August 21
0=no lodging; 9= completely flat

POAST/TREFLAN HERBICIDE TRIAL - FLAX - DICKINSON

	Crop stand		Crop height		---- Straw yield ----	

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Treatment	1994	1995	1994	1995	1994	1995
	plants ft^{-2}		inches		lbs/acre	
Seeding date (SD)						
Early	--	--	--	19	2160.1	2488.5
Late	--	--	--	28	1508.8	3810.3
Grass control (GC)						
None (N)	--	26.0	--	23	1460.6	2666.3
Poast (P)	--	29.7	--	24	1602.4	3322.0
Treflan (T)	--	30.7	--	24	2440.4	3459.8
Mean	--	28.8	--	24	1834.5	3149.4
CV(%)	--	12.6	--	1.9	16.6	13.2
Analysis of Variance						
SD	--	--	--	*	***	NS
GC	--	--	--	NS	***	**
SD x GC	--	--	--	NS	NS	NS
Contrasts						
N vs P and T	--	--	--	NS	***	***

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P vs T	--	--	--	NS	***	NS

Treatment	Visual control				Yield	
	Grassy weeds		Broadleaf weeds		Total weeds	
	1994	1995	1994	1995	1994	1995
	%				lbs/acre	
Seeding date (SD)						
Early	48	62	37	63	2721.9	482.7
Late	57	62	41	58	3247.7	639.5
Grass control (GC)						
None (N)	0	0	0	0	4727.7	1279.9
Poast (P)	98	91	44	91	2324.6	204.8
Treflan (T)	60	95	73	89	1902.1	198.6
Mean	52	62	39	60	2984.8	561.1
CV(%)	39	5	67	9	40.0	66.4
	Analysis of Variance					
SD	NS	NS	NS	NS	NS	NS

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GC	***	***	***	***	***	***
SD x GC	NS	NS	NS	**	NS	NS
Contrasts						
N vs P and T	***	***	***	***	***	***
P vs T	**	*	*	NS	NS	NS

POAST/TREFLAN HERBICIDE TRIAL - FLAX - DICKINSON

Treatment	Yield					
	Grassy weeds -		Broadleaf weeds		Flax seed	
	1994	1995	1994	1995	1994	1995
	lbs/acre				bu/acre	
Seeding date (SD)						
Early	810.5	293.6	1911.4	189.0	9.9	34.4
Late	516.4	380.4	2731.3	259.1	5.7	17.5
Grass control (GC)						
None (N)	1145.8	789.6	3580.8	490.3	5.2	23.8
Poast (P)	445.0	41.7	1878.5	163.1	6.6	28.5

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Treflan (T)	397.5	179.8	1504.6	18.8	11.5	25.6
Mean	663.4	337.0	2321.3	224.1	7.8	25.9
CV(%)	104.9	78.7	50.5	80.9	42.0	12.7
	Analysis of Variance					
SD	NS	NS	NS	NS	NS	**
GC	NS	***	**	***	**	*
SD x GC	NS	NS	NS	NS	NS	NS
Contrasts						
N vs P and T	*	***	**	***	*	*
P vs T	NS	NS	NS	NS	**	NS

Significant at the 0.10 level (P =0.099). Previous crop: Weedy fallow; Soil test results: 122 lbs N, 9 ppm P - no fertilizer applied; Applied Treflan at 1 pt/acre to selected plots on May 12; Planted flax at 42 lbs Pure Live Seed per acre on May 15 (early) and May 31 (late); Applied 2 pt Poast + 2 pt Scoil + 1 pt Buctril on June 13 (early) or June 27 (late); Harvested on August 15 (early) and September 5 (late).

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