ALTERNATIVE CROPS FOR THE BROWN SOIL ZONE: CROP COMPARISONS IN FOUR CROPPING SYSTEMS

P.R. Miller, J. Waddington, D.A. Derksen, and C.L. McDonald
AAFC Research Centre, Swift Current

Introduction

Grain producers are seeking increased profitability and economic stability after a prolonged period of depressed cereal prices which have eroded net farm income in the Brown soil zone. Greater crop diversification offers one solution, as oilseed and pulse crop markets react independently of cereal markets. This economic reality has been recognized by producers in the Brown soil zone where, in 1994, alternative crops (including canaryseed) were seeded on more than 600,000 of 7 million total cropland hectares, representing 15% of the seeded area. Cropping practices for alternative crops were adapted from more humid soil-climatic regions, and the limits of their application in the semiarid Brown soil zone are largely unknown. Western Canadian plant breeding programs have been productive, providing improved cultivars and new crop types which may be better adapted to drier regions. Furthermore, improvements have been made in machine design and in tillage management practices which may prove complementary to the production of alternative crops and to improved conservation of soil and water resources. Research into the production of alternative crops in the BSZ will provide new knowledge aimed at increasing and stabilizing economic returns, diversifying the production base, conserving soil and water resources, and promoting value-added activities. The goal of this research is to compare grain production and quality of several alternative crops, relative to spring wheat, amid four cropping systems; and, to measure the effects of alternative crops on a subsequent wheat crop. Specific research questions to be addressed are:

1. What are the relative production levels for selected alternative crops on fallow vs. stubble in the Brown soil zone?
2. Does tillage system affect oilseed and pulse crop performance?
3. What are the relative yields of spring wheat on different crop stubbles and do they relate to water use by the previous crop?

Qualifying Statement

The following report represents preliminary data from a continuing experiment. No conclusions will be drawn at this time. Data from 1993 and 1994 at Swift Current will be presented along with 1994 data from Assiniboia. At Swift Current, precipitation patterns during the May 1 - July 31 growing season contrasted strongly for 1993 and 1994. In 1993, May was markedly drier than normal, June was near average and 250% of long-term normal precipitation was recorded in July. In 1994, May was markedly wetter than normal, June was near average and only 35% of long-term normal precipitation was recorded in the critical month of July. Additionally, 1994 was characterized by unusually large amounts of stored soil moisture at both locations. The total May-July rainfall recorded at Swift Current equalled 100% of long-term normal values (LTA = 158 mm) while the same at Assiniboia equalled only 55% of long-term normal values (LTA = 168 mm) representing an unusually dry growth environment.

Experimental Details

The alternative crop treatments include four pulses; *Othello* pinto bean, desi chickpea, Laird lentil, and Express (Trapper in 1993) field pea; and three oilseeds; brown mustard, *Saffire* safflower and *AC Sierra* sunflower. *Katepwa* wheat served as the check in 1993 and sawfly-resistant *Lancer* wheat was included as a check in 1994. Tillage treatments include stubble and fallow phases compared in zero- and conventional tillage systems for all crops. Chem fallow consisted of four applications of glyphosate at a rate of 0.89 kg a.i. ha^{-1}. Conventional fallow consisted of four cultivations per season plus a single preseed cultivation. Conventional stubble consisted of a single preseed cultivation. The yield of spring wheat was measured in the subsequent year. This experiment was initiated in 1992 at Swift Current and in 1994 at Assiniboia.

The experimental design is a latin square in a split-plot arrangement, with tillage treatments as main plots, and crops as subplots. The size of the experimental unit is 2 x 6 m and the total plot is harvested. A modified hoe press drill was used to seed all crops at a row spacing of 18.3 cm. Soil tests were taken in stubble and fallow areas the previous fall and plots were fertilized according to recommendations for spring wheat. Weed control was achieved by applying granular trifluralin at 1.1 kg a.i. ha^{-1} on all plots except wheat in the fall previous to planting. Fall and spring cultivations were used to incorporate the trifluralin in conventional fallow; a single spring cultivation was used in conventional stubble and the zero-till plots were unincorporated. Some hand-weeding was required. The subsequent wheat crop was fertilized uniformly according to soil test recommendations in the wheat plots. Bromoxynil(0.28 kg a.i. ha^{-1}) plus MCPA (0.28 kg a.i. ha^{-1}) was applied to the subsequent wheat crop. Crop and soil data recorded included: days to emergence, flowering, and maturity; stand density; plant height; machine-harvested grain yield and quality; soil moisture & N use; and water-use-efficiency. Subsequent wheat crop data collected includes plant height, days to maturity, machine-harvested grain yield and quality.

Preliminary Results

Seedling Emergence

The zero-tillage stubble treatment consistently showed lower emergence in 1993 which caused some contrasts between fallow and stubble to appear significant (Table 1). Ample straw residues were apparent on the stubble blocks and may have interfered with the direct seeding operation. Seedling emergence did not differ for fallow vs. stubble or conventional vs. zero-tillage in 1994 at Swift Current. Seedling emergence on fallow was generally lower for some crops at Assiniboia due to excessive preseeding tillage which left the soil drier to a 10-cm depth relative to the stubble blocks.

Table 1. Comparisons of seedling emergence for fallow vs. stubble at Swift Current in 1993 and 1994 and Assiniboia in 1994 and conventional vs. zero-tillage at Swift Current in 1993 and 1994.

Crop	Swift Current				Assiniboia
	1993		1994		1994
	F¶ vs S	CT vs ZT	F vs S	CT vs ZT	F vs S§
bean	NS	NS	NS	NS	NS
chickpea	* (F)†	NS	NS	NS	* (S)
lentil	NS	NS	NS	NS	NS
pea	* (F)	NS	NS	NS	NS
mustard	* (F)	NS	NS	NS	NS
safflower	NS	* (CT)	NS	NS	* (S)
sunflower	NS	NS	NS	NS	NS
wheat	* (F)	NS	NS	NS	* (S)

¶ F = fallow; S = stubble; CT = conventional tillage ZT = zero-tillage.
§ Comparison made across CT only.
† Treatment indicated in brackets was greater.
* Significant at the P = 0.05 probability level according to orthogonal contrasts.

Maturity

Crop maturities averaged approximately 2 1/2 days earlier for fallow-seeded treatments in 1993 (Table 2). It is unusual for fallow-seeded crops to mature before stubble-seeded crops but the 1993 growing season was characterized by a highly abnormal precipitation pattern which provided no moisture stress during reproductive growth stages of the crops. It is possible that the stubble blocks, having been cropped to wheat for the two previous years, were able to supply greater soil nutrients as a result of decomposing straw residues late in the growing season. Crop maturity differences were generally not associated with cropping system treatments in 1994.

Table 2. Comparisons of days to maturity for fallow vs. stubble and conventional vs. zero-tillage at Swift Current in 1993 and 1994.

Crop	1993		1994	
	F¶ vs s	CT vs ZT	F vs S	CT vs ZT
bean	* (S)§	NS	NS	NS
chickpea	NS	NS	NS	NS
lentil	* (S)	* (ZT)	NS	NS
pea	* (S)	* (ZT)	NS	NS
mustard	* (S)	NS	* (F)	NS
safflower			NS	* (CT)
sunflower	* (S)	* (ZT)	NS	NS
wheat	NS	NS	* (F)	NS

¶ F = fallow; S = stubble; CT = conventional tillage; ZT = zero-tillage.
§ Treatment indicated in brackets was longer.
* Significant at the P = 0.05 probability level according to orthogonal contrasts.

Grain Yield

Grain yield was generally higher for fallow-seeded crops at Swift Current in 1993 and at Assiniboia (Table 3). Differences in grain yield were not observed for fallow vs. stubble treatments at Swift Current in 1994. Differences in grain yield were generally not associated with tillage treatment. Where yield differences occurred between fallow-seeded and stubble-seeded crops, the relative differences were generally smaller for the pulse crop entries. Mustard has consistently shown the largest relative yield difference between fallow- and stubble-seeding.

Table 3. Comparisons of yield for fallow vs. stubble and conventional vs. zero-tillage at Swift Current in 1993 and 1994 and Assiniboia in 1994.

Crop	Swift Current				Assiniboia
	------- 1993 -------		------- 1994 -------		1994
	F¶ vs S	CT vs ZT	F vs S	CT vs ZT	F vs S
bean	* (F)§	NS	NS	NS	* (F)
chickpea	NS	NS	NS	NS	* (F)
lentil	* (F)	NS	NS	NS	* (F)
pea	* (F)	* (ZT)	NS	NS	NS
mustard	* (F)	NS	* (F)	NS	* (F)
safflower	* (F)	* (CT)	NS	NS	* (F)
sunflower	* (F)	NS	NS	NS	* (F)
wheat	* (F)	* (ZT)	* (F)	NS	* (F)

¶ F = fallow; S = stubble; CT = conventional tillage; ZT = zero-tillage.
§ Treatment indicated in brackets was greater.
* Significant at the P = 0.05 probability level according to orthogonal contrasts.

Water Use

Crop water use was determined at Swift Current during two growing seasons with remarkably contrasting precipitation patterns. The later maturing oilseeds, safflower and sunflower, consistently used the greatest water. However, an analysis of means conducted for water use regressed on days to maturity was not significant (R^2 - 0.02) for all crops for the two years. When only 1994 data was considered, the R^2 improved to 0.33 but remained nonsignificant.

Table 4. Comparisons of water use (cm) at Swift Current in 1993 and 1994.

Crop	1993	1994
safflower	40.2	31.6
sunflower	37.3	30.5
wheat	32.3	29.4
chickpea	38.9	28.0
mustard	33.3	26.2
bean	36.4	26.0
lentil	37.3	25.5
pea	36.6	24.3
LSD (0.05)"	1.05	1.47

Least significant difference at the 0.05 probability level.

Subsequent Wheat Yield

All plots were tilled and fertilized uniformly according to soil test recommendations for spring wheat. Higher wheat yields on chickpea, lentil, and pea stubbles were observed (Table 5). Unusually low wheat yields were observed on the mustard plots due to failure in controlling volunteer mustard seedlings at an earlier stage.

Table 5. Subsequent wheat crop at Swift Current in 1994.

1993 Crop	height	yield	Kwt
	(cm)	(kg ha^{-1})	(g 1000 $seeds^{-1}$)
chickpea	89.5	2792	30.6
pea	88.2	2630	30.7
lentil	86.7	2582	31.1
bean	86.0	2337	31.0
sunflower	83.4	2267	30.5
wheat	83.4	2202	30.8
safflower	81.5	2068	30.7
mustard	71.0	1130	30.4
LSD (0.05:*	1.89	188	0.49

¶ Dense population of volunteer mustard seedlings were not controlled at optimal timing.
* Least significant difference at the 0.05 probability level.

Acknowledgements

This research was supported, in part, by the Canada-Saskatchewan Agriculture Green Plan Agreement.

Mr. Al Gellert, producer cooperator, contributed greatly to the success of the Assiniboia site.