Alternative crops for extending spring wheat rotations in the semi-dry prairie

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Introduction

In 199 1, with wheat grown on more than 98% of the seeded acres, producers in the semi-dry prairie were dependent on low-value wheat markets and were quickly turning to higher value alternative crops. They demanded that research be conducted to learn the fit for alternative crops in this water-limited region. The first response was the Alternative Crops X Tillage experiment started at SPARC which addressed the following questions:

1. Which alternative crops have good potential for the Brown soil zone?
2. Which alternative crops are best grown on fallow; which on stubble?
3. Are alternative crop yields higher with direct-seeding?
4. How does soil water use compare among alternative crops?
5. How do the alternative crops affect a wheat recrop?

Experimental Design

The experimental design is a randomized complete block in a split-plot arrangement with tillagc system as the main plot and crop as the subplot (2 X 6 m). Tillage treatments included both stubble (wheat) and fallow phases for direct-seeding and minimum tillage systems. The alternative crop treatments included 4 pulses; ***Othello*** pinto bean (dropped after 1994, data not presented), ***Cheston*** desi chickpea, Laird lentil, and yellow field pea ***(Trapper*** 1992-93, ***Express*** 1994-95, ***Grande*** 1996); and 3 oilsecds; mustard (common brown 1992-94, ***Cutlass*** Oriental 1995-96), ***Saffire*** safflower and dwarf sunflower (AC ***Sierra*** 1992-94, ***P6150*** 1995-96). Spring wheat ***(Lancer*** 1992-94, ***Katepwa*** 1995-96) served as the check. Plots were fertilized according to soil test recommendations for normal risk spring wheat production in the Brown soil zone. A modified hoe press drill was used to seed all crops at a row spacing of 8 inches with mid-row banding of N fertilizer. Phosphate fertilizer was placed with the seed. Weed control was achieved by a combination of herbicide use and hand weeding. Soil samples were taken from all subplots after harvest to determine soil water use. Based on average soil N availability in the stubble of the wheat check, spring wheat was grown uniformly across the various crop stubbles the following year to measure grain yield and quality. This experiment began in 1992 at Swift Current and in 1994 near Assiniboia. The 1995 data from Swift Current was not included due to large yield losses in many plots from a late summer hailstorm. Only in 1994 and 1996 were terminal summer droughts experienced at both sites for this expcrimcnt. The remaining three site-years were characterized by unusually large amounts of summer rainfall.

Alternative Crop Yields

Which alternative crops have good potential for the Brown soil zone? Results have been presented as a summary for all seven site-years and for only the subset of four site-years where terminal summer drought occurred (Table 1). Conducting yield **analyses** by the different sets of site-years made little difference for most crops, except for mustard which yielded better when data from the wet growing seasons was included, and for safflower which yielded better in the subset of years with terminal drought. **Field pea yields were surprisingly high during all site-years for a crop not considered adapted to the Brown soil zone.** Based on its outstanding performance in this experiment, and several other experiments begun in recent years at SPARC, we will continue to aggressively study the optima1 fit for field pea in cropping systems for the semidry prairie. Lentil and desi chickpea yields were similar for this experiment. However, this comparison is highly misleading because a well adapted lentil variety was compared to a non-adapted chickpea pseudo-variety, as no adapted varieties were available at the time this experiment was conducted. Large (25 to 30%) yield improvements in chickpea are expected to result quickly from the plant breeding program at the Crop Development Centre, which will substantially improve the productivity of chickpea relative to lentil. Seed yields of dwarf sunflower were disappointing low for all site-years in this experiment. Dry bean was dropped after 1994 due to its low yield.

Which alternative crops are best grown on fallow; which on stubble? When extending crop rotations in the Brown soil zone it is key to know whether an alternative crop is most suited to production on fallow or stubble. In this experiment the pulse crops grown on stubble retained a larger portion (83-90%) of their fallow yield potential than wheat (74%) or mustard (63%). **This indicates that pulse crops may be a relatively good choice for recropping wheat stubble, while mustard (or canola) production would be least risky on fallow.**

Are alternative crop yields higher with direct-seeding? Direct-seeding of alternative crops was expected to producer larger yields, especially in wheat stubble where microclimate benefits were most likely to occur. Statistically significant yield differences were not recorded between tillage systems in either fallow or stubble but a small consistent yield benefit averaging 4% greater for direct-seeding was noted for all seven crops when grown in stubble. The size of this response is similar to that reported by Brandt (1992).

The Wheat Recrop

How does soil water use compare among alternative crops? Water, or the lack of it, is the factor most strongly limiting to crop yield in the semi-dry prairie. It is important to know the water use characteristics of all crops so that cropping systems can be designed which optimize water-use-efficiency of the whole system. Soil water use was determined gravimetrically in this experiment to see if there were large differences in the amounts of water used by the various crops. Although the water USC data was not completely analyzed at the time this paper was written, preliminary indications from this and other related studies, are that field pea and lentil grown in fallow used less soil water to a depth of 120 cm than wheat, and that dwarf sunflower and safflower used more water than wheat. Water USC by mustard and chickpea was not different from wheat.

How do the altemativc crops affect a wheat rccrop? This is a key question in wheat country, which, if answered, would presently address 85% of the recrop acres sown on altemativc crop stubbles. The pulse and oilseed crop entries caused distinctly different responses in the following wheat crop, compared with back to back wheat. Mustard and

Table 1. Average yields (lb/ac) of alternative crops for fallow and stubble phases, averaged for both tillagc systems for all seven site-years and for a subset of four site-years with a terminal drought, 1992-96 at Swift Current and 1994-96 at Assiniboia.

Crop	Fallow		Stubble		Stubble/Fallow
	7-yr	4-yr	7-y-r	4-yr	4-yr
		lb/ac		-----	%
Field pea	2510	2330	2180	2080	89
CWRS wheat	2410	2280	1660	1680	74
Desi chickpea*	1400	1370	1060	1240	90
Lentil	1340	1270	1090	1060	83
Mustard	1520	1270	960	800	63
Safflower	790	1250	780	1130	91
Sunflower	790	790	750	700	88
LSD(0.05)	640	550	480	480	

* Ascochyta was present in chickpea plots from 1994 and 1996 at Swift Current and control was achieved with repeated applications of Bravo fungicide.

sunflower stubbles had no measurable effect on the yield of a following wheat crop, while safflower stubble appeared to depress wheat yields slightly (Table 2). All three pulse crop stubbles showed a positive yield response in a following wheat crop, averaging 15% higher yield than wheat grown after wheat. What about grain quality? The story continues to get better for the pulses as they averaged 1.2 protein percentage units higher than wheat grown after wheat. The oilseed crops also caused higher protein levels in the following wheat crop, averaging 0.8 protein units higher than wheat grown after wheat.

Conclusions

Small-plot research has come under increasing criticism for failing to reflect production issues at the landscape scale - to the point where some producers have declared all small-plot research to be 'worthless'. What have we learned from this small-plot experiment? Three pulse crops, field pea, chickpea and lentil, have a relatively strong fit on wheat stubble which could be an important key to diversifying and extending cropping systems in the semi-dry prairie. This agrees with recent producer experience The optimal fit for mustard (and therefore canola?) is on fallow, perhaps an important restriction for this region. Wc have committed to new research tracks at SPARC which will further explore the fit for pulse and *Brassica* oilseed crops in this region.

What else have we learned? There appears to be a small positive benefit to alternative crop production with direct-seeding. This information has a positive fit with the sustained movement toward direct-seeding systems. Water-use research is showing that the pulse

Table 2. Yield and protein of a CWRS wheat recrop grown on alternative crop stubbles for 5 site-years, 1993-96 at Swift Current and 1995 near Assiniboia.

Stubble	Yield	Protein
	----- lb/ac ------	13.5% moist.
Field pea	2284	12.65
Lentil	2233	12.38
Desi chickpea	2200	12.44
Dwarf sunflower	1990	12.1
Oriental mustard	1968	12.19
CWRS wheat	1948	11.32
Safflower	1852	11.95
LSD(0.05)	140	0.47

crops, field pea and lentil, use less soil water during the growing season than wheat. Water use by chickpea and mustard is similar to wheat while dwarf sunflower and safflower use greater amounts. Is this important information for designing extended wheat-based cropping systems? Probably. New research tracks have been started at SPARC to aggressively study the role of water availability for alternative crops grown in the semidry prairie. Perhaps the most exciting piece of information to come out of this small-plot experiment is the cropping sequence benefit of pulse crops to wheat yield and protein, relative to that from the oilseed crop entries. New research tracks have been started that evaluate economic and environmental sustainability of diversified cropping systems while integrating larger-scale machinery and optimal management practices for all crops.

References

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