Grain Yield and Protein Content of Durum Wheat Preceded by Green Manure

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Introduction

Nitrogen (N) fertilizer is a major input in crop production and inadequate or excessive use of N fertilizer can have significant environmental consequences. Growing green manure crops to fix atmospheric N is considered an alternative approach for N management in cropping systems. However, in the semiarid Canadian prairie, there is concern that grain yields may be decreased for crops grown after green manure due to the depletion of soil water by previous green manure crops. This 3-yr study was conducted to quantify grain yield and protein content of durum wheat grown after various green manure crops in comparison with durum grown after chem-fallow or spring wheat and field pea harvested for grain.

Materials & methods

Study was conducted at Swift Current on a Chernozemic soil between 2006 and 2009. In 2006, 2007, and 2008, three green manure crops: chickling vetch (*Lathyrus sativus* var. AC-greenfix), black lentil (*Lens culinaris* var. Indianhead), forage pea (*Pisum sativum* var. CDC Sonata), along with field pea (*Pisum sativum* var. CDC Eclipse) and spring wheat (*Triticum aestivum* var. AC-Lillian) were planted using a randomized complete block design with four replicates. The three green manure crops were terminated in early July, September, or left for frost-kill, forage pea was harvested for biomass at blooming stage, and field pea and wheat were harvested at full maturity for grain. A chem-fallow was included as the check.

In 2007, 2008, and 2009 durum wheat (var. Strongfield) was planted on fields preceded by various crop types. Soil water and soil N at various soil depths were measured at planting. Durum wheat grown on spring wheat stubble was fertilized at a rate of 45 kg ha^{-1} of 11-52-0-0 fertilizer, and durum grown on chem-fallow, green manure or pea stubble received no fertilization.

Results & discussion

Weather: The growing-season (1 May – 31 Aug) precipitation was 219, 194, 129, 317 and 176 mm, in 2005, 2006, 2007, 2008 and 2009, respectively. Compared to the 50-yr average at the experimental site, 2007 was drier, 2008 was wetter, and the rest of the years were near the long-term norm.

Effect on durum grain yield: There was a significant year x treatment interaction on grain yield and protein content of the re-cropped durum wheat (data not shown). However, close examination revealed that treatment effect followed a similar trend in the three years; therefore 3-yr averages are presented, unless the trend differed significantly.

On average, durum wheat grown on chem-fallow, AC-greenfix and black lentil produced the same grain yield (**Fig. 1**); they were 41% greater compared to durum wheat grown after spring wheat, even though the latter wheat was fertilized and the former was not.

On average, the previous forage pea harvested at blooming stage for animal feed decreased the grain yield of the following durum wheat by 11.7% compared to durum wheat grown on green manure or chem-fallow.

The previous field pea harvested for grain decreased durum yield in the following year by an average of 22.8% compared to durum wheat grown on green manure or chem-fallow (**Fig. 1**). However, grain yield of durum after field pea (not fertilized) was 21% higher compared to durum grown on spring wheat stubble that was fertilized.

Grain protein content: Grain protein content varied greatly from year to year. In the drier 2007, average protein content was 15.2%, whereas in the wetter 2008 it was 13.2%, while durum grain in 2009 had an average protein content of 14.9%. On average, durum grain protein content was greatest when grown on chem-fallow, AC-greenfix or forage pea fields, and it was lowest when grown on wheat stubble (**Fig. 1**).

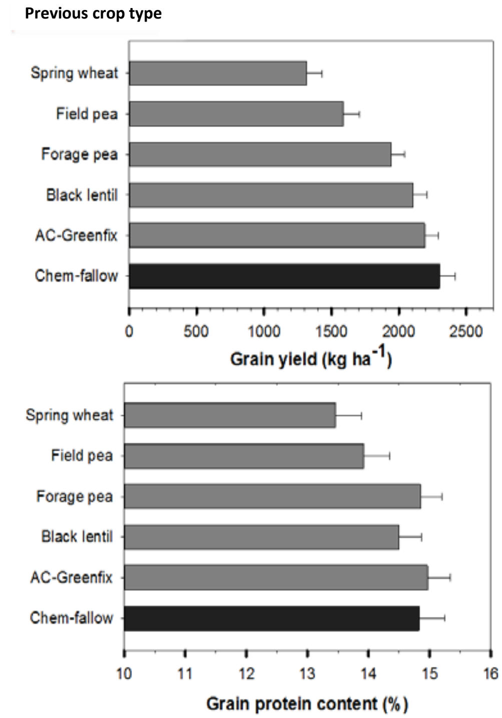

Fig. 1. Durum grain yield (top) and protein content (bottom) in relation to previous crop type or green manure in Swift Current (3-yr average, with the line bars being standard errors).

Tab. 1. Soil N and water in the 0-120 cm measured at the planting of durum wheat the following year

Year effect	Soil N (kg N ha^{-1})		Soil water (mm)	
2009	183	A	232	A
2008	68	B	217	B
2007	47	B	196	C
Effect of previous crop type and termination time				
Chem-Fallow	116	AB	239	A
July termination	124	A	219	B
Sept termination	101	B	212	BC
Frost kill	100	B	231	A
Field pea harvested	96	ABC	199	CD
Forage pea harvested	90	BC	209	BCD
Spring wheat harvested	68	C	195	D

Soil N and water: Soil N in the 0-120 cm depth measured at the planting of durum wheat differed substantially between years (**Tab. 1**). Averaged across all plots, a huge amount of soil N was found in the spring of 2009 which was triple that of 2008 and four times that of 2007. it is unknown if the large amount of soil N in the spring of 2009 was due to large rainfall in the 2008 fall that promoted N mineralization.

The July-termination of green manure led to the highest amount of water conserved in the soil, while leaving green manure plants until frost-kill increased soil N significantly among the three determination dates evaluated (**Tab. 1**).

Conclusions

This 3-year field experiment showed that AC-greenfix and black lentil, used as green manure and terminated in early to mid-July, were comparable to chem-fallow; they all produced significantly greater grain yield with higher protein content for durum wheat grown in the following year compared to the durum wheat grown on spring wheat. More research may be required to define the economics of growing green manure and the potential impact on the environment.

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