Effect of Tillage on Nitrogen Cycling from Annual Legume Green Manures

Mac Burgess, Perry Miller and Clain Jones

Montana State University, Bozeman, MT

Fertilizer Facts

Fertilizer Check-Off

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Introduction

Annual legume green manure (LGM) cover crops may be valuable for enhancing soil quality when grown in place of fallow in rotation with cereals. Short term expectations for N fertilizer requirements to optimize yield and protein of wheat following LGM's need to be established, especially in no-till production. The objectives of this project were to measure yield and protein of wheat grown in rotation with early-terminated pea and lentil green manures in comparison to fallow under several tillage management scenarios.

Methods

Field studies were conducted at Amsterdam, MT from 2007 to 2010 at a site with an elevation of 4700 feet, deep silt loam soils, and average annual precipitation of 14.7 inches. Spring-planted pea (c.v Arvika) and lentil (c.v. Richlea) were grown as green manures in 2007, 2008, and 2009, direct seeded into wheat or barley stubble. All green manures were terminated at first bloom, which occurred between the 15th and 29th of June each year. Green manures were terminated with either herbicide (NT) or tillage (T), and then subsequent weed control was performed with herbicide or tillage, resulting in 4 tillage treatments:

- NT – No Till, herbicide only
- NTT – Herbicide termination, tilled after
- TNT – Tillage termination, herbicide after
- T – Tilled only

No-till LGM termination was accomplished with 22 oz/acre of a 5.5 lb/gal (acid equivalent) formulation of glyphosate. Tillage was performed with a tandem offset disc for pea termination, a chisel plow for lentil termination and fallow maintenance, and a field cultivator with trailing roller-baskets for seedbed preparation of all treatments that had been previously tilled. Tilled plots received three or four tillage operations depending on year, while the NTT and TNT treatments received 1-fewer tillage operation. Fallow check plots were maintained by the same methods.

Soil samples were analyzed for water and nitrate to a depth of 3 feet at the time of LGM termination, again in the fall, and, in 2008 and 2009, yet again the next spring prior to spring wheat planting. In year-2, spring wheat (c.v. Choteau) was planted at four fertilizer rates (0, 22, 45 and 90 lb/acre of N).

Results

Year-1 legume green manure

Average biomass production was 2500 lb/acre for pea and 1100 lb/acre for lentil. Glyphosate provided slow termination of rapidly growing pea and lentil, taking 3 weeks or more before complete senescence. No alternative herbicide treatments were explored in this project. Soil water use (compared to fallow) measured at LGM termination was 2.9 inches for pea and 1.5 inches for lentil. Surface LGM residue reduced soil water loss later in the fallow season, however, and by the following spring the difference compared to fallow was 1.4 inches for pea and 0.7 inches for lentil. The only effect of tillage on soil water occurred over the winter of 2008-2009 when NT plots accumulated 1.0 inches more water

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than plots that had received any amount of tillage, likely due to snow catch. The magnitude of this snow catch effect may partially be a function of the small plots used for this study and might not occur over an entire field. Soil nitrate N the next spring was 10 lb/acre greater after pea green manure than fallow, while lentil had no effect on spring soil nitrate. Tillage did not affect measured soil nitrate N.

Year-2 wheat test crop

Wheat yield and protein responded to N fertilizer, LGM treatment, and tillage in a 3-way interaction (Figure 1). These results are consistent with LGM providing an increase in available N, and tillage accelerating the release of that N. Importantly, reduced-intensity tillage was sufficient to realize the benefit of the LGM. Under no-till management, there was no difference in yield among LGM and fallow treatments. With tillage termination (e.g. T and TNT treatments), both pea and lentil LGM increased wheat yield relative to fallow. Under the NTT treatment, only pea LGM increased yield relative to fallow. Under the most responsive case of no added N fertilizer, tillage of pea or lentil LGM provided an additional 5 bu/acre yield increase over tilled fallow. The yield differences between LGM and fallow diminished with increasing N fertilizer rate, indicating that N availability was the primary mechanism of increased yield from LGM.

Pea LGM increased grain protein consistently, under all tillage regimes, and at all N-fertilizer rates, by an average 0.8 percentage points. Grain protein following lentil LGM generally did not differ from fallow.

Fertilizer Facts

- Pea green manure produced more biomass than lentil, and used more water.
- Pea green manure increased spring soil nitrate N by10 lb/acre.
- Some tillage was necessary for green manure to increase wheat yield.
- Pea green manure increased wheat protein regardless of tillage.

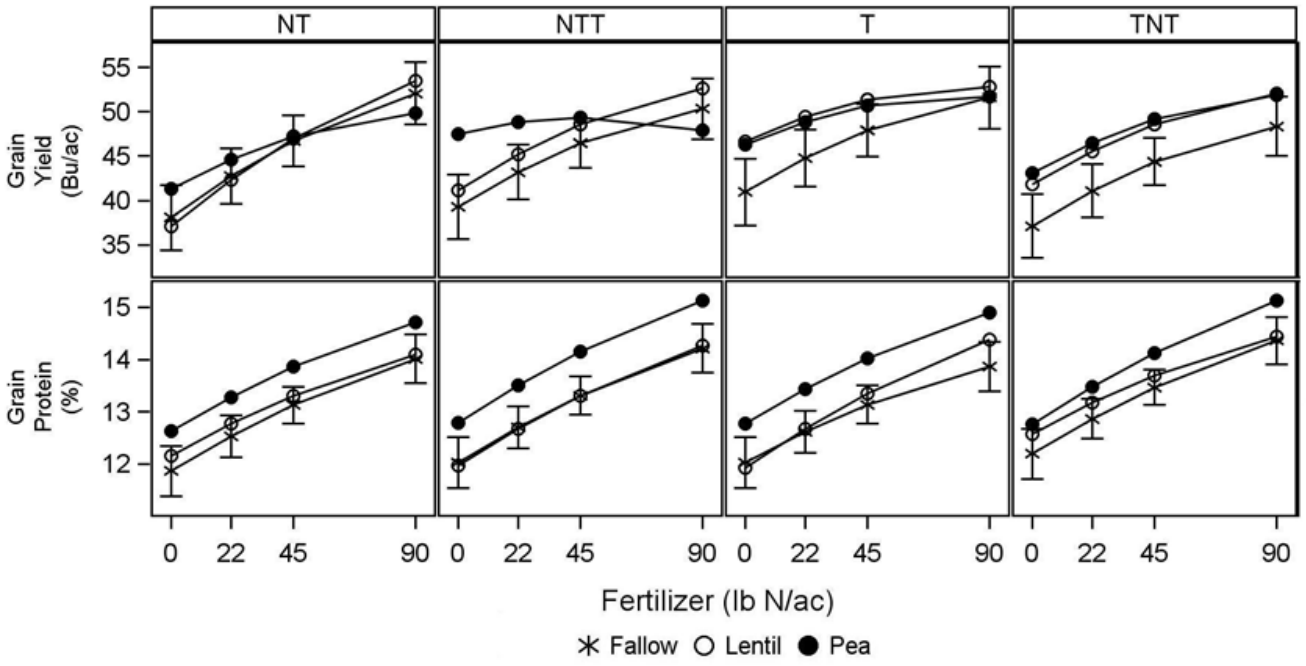

Figure 1. Spring wheat yield and protein following pea or lentil green manure or fallow treatments under four tillage regimes: No-till (NT), No-till-Till (NTT), Till (T), Till-No-till (TNT), Amsterdam, MT, 2008-2010. Lentil or pea means that don't overlap with fallow error bars indicate significant differences with 95% certainty**.**

Edited by Clain Jones, Extension Soil Fertility Specialist, and Kathrin Olson-Rutz, Research Associate