Perennial Forage Stand Duration Impacts on Spring Wheat Yields in a Semiarid Cropping System

Jose G. Franco[a], John R. Hendrickson[a], Sara E. Duke[b], David W. Archer[a], Mark A. Liebig[a], Kristine A. Nichols[c], Donald L. Tanaka[a]

[a]USDA-Agricultural Research Service, Northern Great Plains Research Laboratory, P.O. Box 459, Mandan, ND 58554, USA
[b]USDA-Agricultural Research Service, Plains Area, 2881 F&B Rd., College Station, TX 77845, USA
[c]Rodale Institute, 611 Siegfriedale Road, Kutztown, PA 19530, USA

jose.franco@ars.usda.gov

Introduction

- Perennial forages have the potential to diversify annual crop rotations and provide ecosystem services.
- Yield benefits to the annual cash crop have been observed after a perennial phase.
- Less is known about the effect of perennial phase duration on yield benefits and extent to which those benefits are observed following the perennial phase.
- Yield benefits may vary depending upon the perennial crop type and duration of perennial phase.

Objectives

1) Determine an optimal length of time for a perennial phase in a crop rotation.
2) Determine the best perennial species to incorporate into an annual cropping system.
3) Determine the duration of perennial effects following conversion to annual crops.

Materials and Methods

- Spring 2006: 9 x 36.5 m plots were seeded to 1) intermediate (IM) wheatgrass only, 2) switchgrass only, 3) field peas (in place of alfalfa), 4) intermediate wheatgrass and field peas (in place of alfalfa), 5) switchgrass and field peas (in place of alfalfa) and 6) an annual crop (field peas)
- Spring 2007: alfalfa was seeded in place of field peas except for the annual crop, which was seeded to a “business as usual” continuous spring wheat.
- Spring 2008: first breakout strip (strip A in Figure 1) was sprayed with glyphosate and seeded to spring wheat. Perennial strips broken out sequentially each year thereafter with the last breakout strip converted in 2011.
- 60 lbs N fertilizer was applied to all grass only monocultures, including the annual spring wheat crop, up until the year they were broken out.
- The last breakout strip (strip D in Figure 1) was fertilized annually with 60 lbs N for the duration of the study.

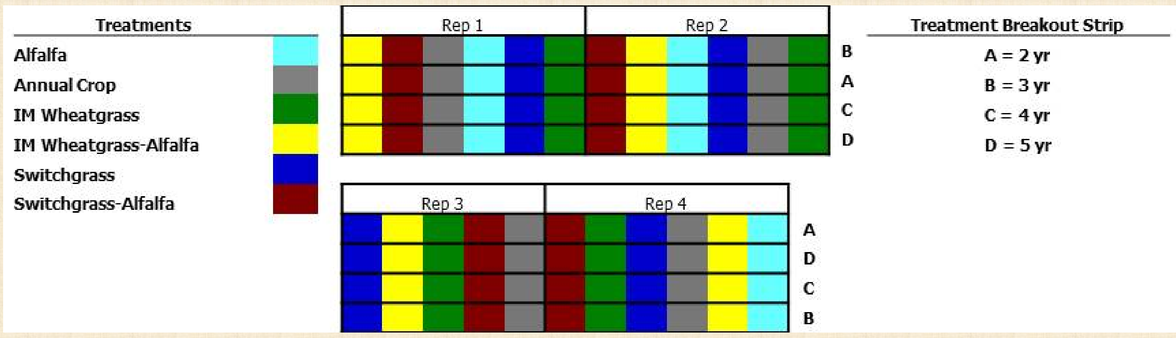

Figure 1. Experimental design and plot layout of a perennial forage-annual cropping system study in Mandan, North Dakota, U.S.A. showing cropping treatments, breakout strips and corresponding perennial phase length. Breakout strip A was converted to spring wheat in 2008 followed by strip B in 2009, strip C in 2010, and strip D in 2011. This corresponds with 2, 3, 4, and 5 years of a perennial phase, respectively.

Figure 2. Study site in Mandan, North Dakota in 2010 with experimental treatments comprised of alfalfa (a), switchgrass (b), intermediate (IM) wheatgrass (c), alfalfa-IM wheatgrass, alfalfa-switchgrass and spring wheat.

Preliminary Results

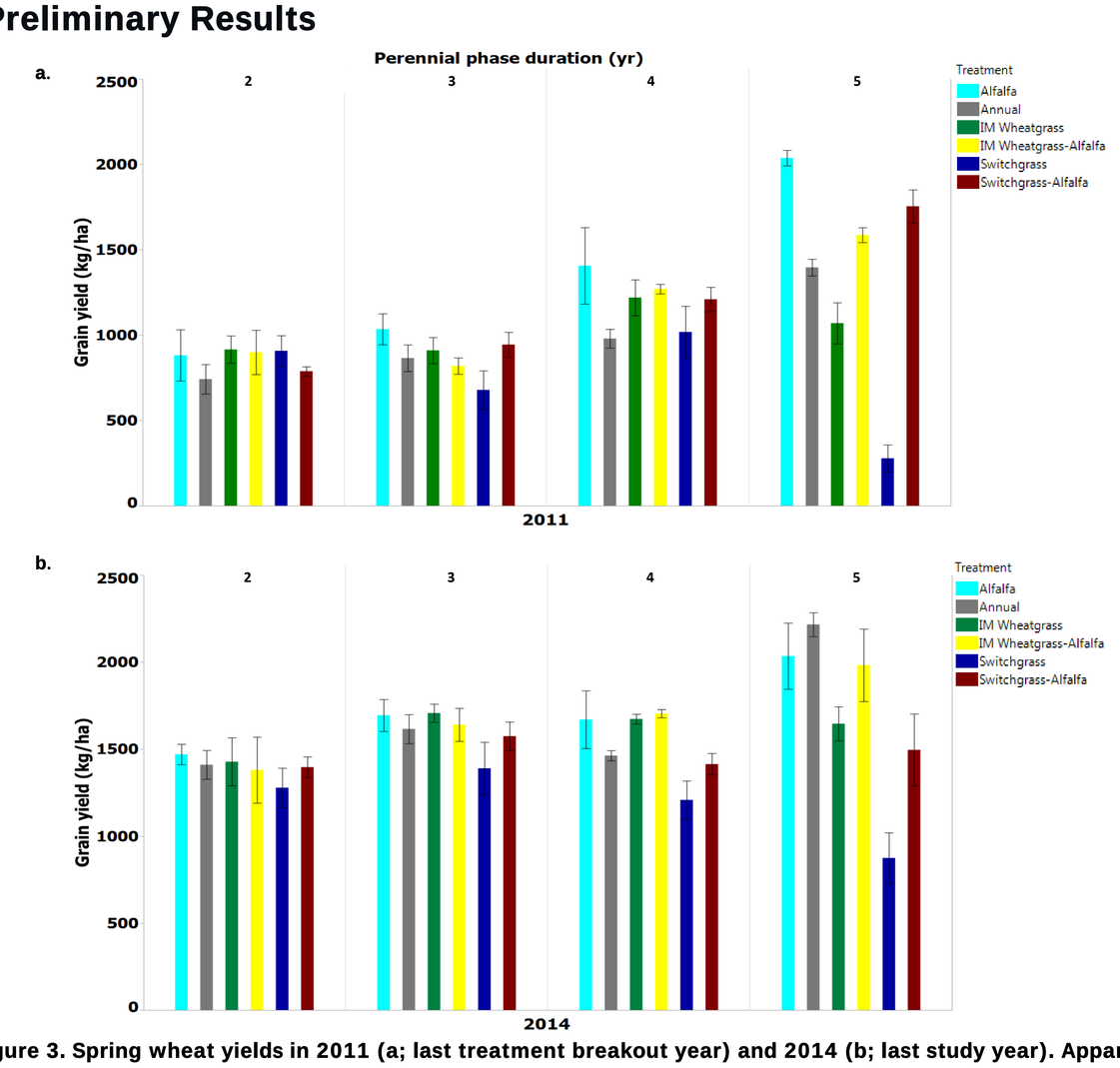

Figure 3. Spring wheat yields in 2011 (a; last treatment breakout year) and 2014 (b; last study year). Apparent differences are observed due to perennial phase duration (2, 3, 4, or 5 years) and between species and mixtures.

Discussion

- Spring wheat yields benefited after only 2 years of a perennial phase as compared to the business as usual annual spring wheat, though the greatest yield benefit was realized after 4 years of a perennial (Fig. 3a).
- Treatments with alfalfa yielded the highest in 2011 (Fig. 3a) and only continuous spring wheat, which had been fertilized annually since 2007, yielded higher in 2014 (Fig. 3b).
- Less expected was the impact of IM wheatgrass, with yields higher than continuous spring wheat after 4 years of a perennial phase (Fig.’s 3a and 3b).
- Yield benefits were evident even after 3 years following conversion from alfalfa and IM wheatgrass-alfalfa with yields exceeding or nearing those of annual spring wheat yields fertilized annually (Fig. 3b)