Strip-tillage as a tool for maintaining yield in mature Kernza® intermediate wheatgrass stands

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Background

Kernza® intermediate wheatgrass (*Thinopyrum intermedium*) varieties bred for perennial grain production have potential to contribute to sustainable cropping systems by providing ecosystem services such as soil building and water quality protection in addition to food and forage[1]. Compared to annual small grain crops, however, grain yields of Kernza® are substantially lower which impacts the economic viability of the crop[2]. Kernza® grain yields have also been found to decline as stands mature, with a large drop in yield often occurring after the second or third harvest[3]. Possible causal factors for this yield decline include intraspecific competition and signaling reducing seed production as Kernza®, a rhizomatous perennial grass, spreads into available space[4,5]. Here we report results of using strip-tillage as a management tool to reduce stand density, with the goal of maintaining yield, in a mature Kernza® stand.

Methodology

This experiment was conducted in a mature stand of Kernza® grown from TLI Cycle 3 seed planted in August 2014. The experimental design was an RCBD replicated five times with three levels of strip-tillage: fall-tilled, spring-tilled, and an untilled control. Strip-tillage treatments were applied on October 20, 2017 and May 9, 2018, in between the third and fourth grain harvests from the field, using an Unverferth Zone Builder Subsoiler, model 122. Plot size was 18.3 m long by 4.6 m wide. All plots were top-dressed with a mix of ammonium sulfate and urea resulting in 74 kg ha^{-1} N applied on April 24, 2018.

Data were collected at IWG grain harvest from one 1.5 m wide strip harvested with an Almaco SPC20-C plot combine on August 27, 2018 and two 0.5 m^2 quadrats harvested by hand in each plot on August 30, 2018. The following variables were analyzed with ANOVA mixed effect models implemented in R v3.5.3:

- Dehulled grain yields from both combine and hand harvests
- Total crop biomass from quadrat samples
- Tiller counts from quadrat samples
- Seedhead (i.e. fertile tiller) counts from quadrat samples
- Components of yield from 10 random seedheads in each quadrat:
  - Seedhead length
  - Spikelet count
  - Floret count
  - Seed count
  - Thousand kernel weight

Results and Discussion

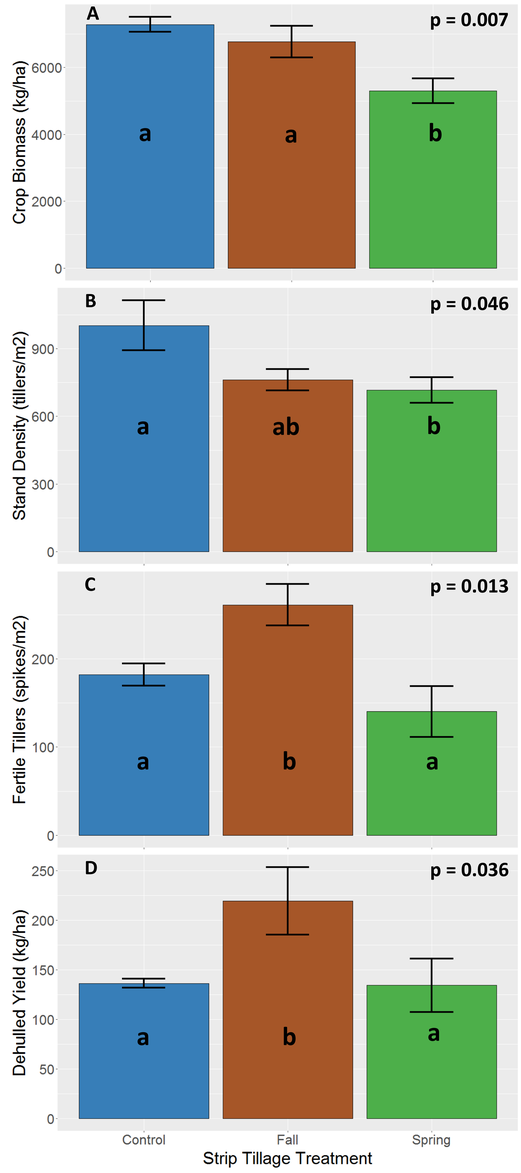

Figure 1: Kernza® intermediate wheatgrass (A) crop biomass, (B) total stand density, (C) fertile tiller density, and (D) hand-harvested dehulled grain yields following fall- and spring-strip-tillage treatments, in comparison to an untilled control.

Strip-tillage treatments impacted several indicators of Kernza® intermediate wheatgrass productivity measured during the 2018 harvest (Figure 1). Total crop biomass was 27% lower in plots that were spring-tilled compared to the control while no difference was observed in fall-tilled plots. Total stand density was 29% lower in spring-tilled plots when compared to the control; fall-tilled plots were marginally lower (p = 0.578; 24%) than the control as well. In contrast, fertile tiller density was 46% and 30% higher in fall-tilled plots than either spring-tilled or control plots, respectively. Moreover, grain yields from both hand-harvested quadrats (p = 0.036; 62%) and combined strips (p = 0.008; 36%) were higher in fall-tilled plots compared to spring-tilled and control plots. No differences were observed between tillage treatments for spikelet, floret, or seed counts, or seed weights.

These results provide evidence in support of density-dependent intraspecific competition impacting resource allocation to seed production as a causal factor for yield declines observed in Kernza® stands as they age. Post-harvest defoliation treatments have also been found to benefit Kernza® grain and forage yields over time[4], so it is not clear what specific mechanisms may be responsible for this phenomenon. From a crop management perspective these results also suggest that different types and timing of targeted disturbance should be investigated as management tools for Kernza® and other perennial grain crops.

Clockwise from Top Left: Disturbance from spring strip-tillage treatment in April 2018; closeup of strip-tillage equipment in action; Honey Toasted Kernza® cereal produced by Cascadian Farms; Kernza® grain and seedheads (photo credit: The Land Institute); Cornell Sustainable Cropping Systems Lab researcher Sandra Wayman processing quadrat biomass samples; view from the plot combine while harvesting Kernza in August 2018.

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