Managing Winter Annual Cover Crops for Increased Productivity and Soil Health

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Introduction

The imminent depletion of the Ogallala Aquifer demands innovative alternatives for row-crop producers in the Southern High Plains (SHP). Integrating winter cover crops was found to maintain ground cover without depleting the ground water reserves for the subsequent cash crop (Baxter and West, 2017). Soil properties should be further investigated to learn how winter cover crop management strategies may influence soil C inputs and physical properties.

Objectives: Compare residual effects of cover crops and winter management strategies on the productivity of a subsequent no-till, irrigated summer teff hay crop and evaluate soil C and N dynamics and soil physical properties that impact water infiltration and storage (particulate organic matter [POM] and bulk density [BD]). Results will also be compared to the pre-existing warm-season grass pasture (predominantly Old World bluestem).

Materials and Methods

- **Hayfield experimental design**: strip-plot design with irrigation as whole-plot and tillage and forage as sub-plots.
- **Cover crops:** Sept. 2016 - May 2017
  - **Irrigation**: winter dryland or irrigated up to 1″/month of total water delivery (rainfall + irrigation).
  - **Tillage**: no-till or lightly disked (**Fig. 1**).
  - **Forages**: rye, wheat, burr medic, hairy vetch, rape-kale, and unplanted fallow.
- **Teff:** May – September 2017
  - Drilled into cover crop stubble in May 2017 .
  - Irrigated up to 5″/month total water delivery.
  - Fertilized after planting with 60 lbs N/ac.
- **Data collection:**
  - **Forage mass** determined by clipping 1-ft^2 samples 10 weeks post-planting.
  - **Volumetric soil water content** (VWC) monitored weekly with Dynamax Profile Probe at 4, 8, 12, 16, 24, and 40″ depths to make irrigation management decisions.
  - **Bulk density** was measured in the top 2″ of the soil following procedure outlined in NRCS (2004).
  - Two, 2″ soil cores were collected from each plot to determine soil N, C, and POM.
    - Soil N and C were determined by dry combustion in a LECO TruSpec® CN (LECO Corporation, Saint Joesph, MI).
    - Soil POM was determined by Na-hexametaphosphate dispersion (**Fig. 2**). Time did not allow for sand fractions to be separated from the POM, thus data are presented as POM (>53 µm) + sand.
- All data analyzed in SAS 9.4 (SAS Inc., Cary, NC). All error bars represent standard error of the mean (SEM).

Figure 1. Preparing ground for winter cover crops.

Figure 2. Soil POM determination.

Results

Statistical differences were not detected among irrigation, tillage, or forage treatments for soil BD or soil N ($P > 0.10$; Fig. 3, 4). Therefore, results were pooled over all winter crop management strategies and compared to the warm-season pasture that existed pre-trial.

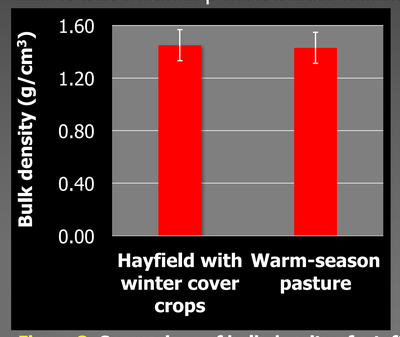

Figure 3. Comparison of bulk density of a teff hayfield following winter cover crops to a pre-existing warm-season grass pasture.

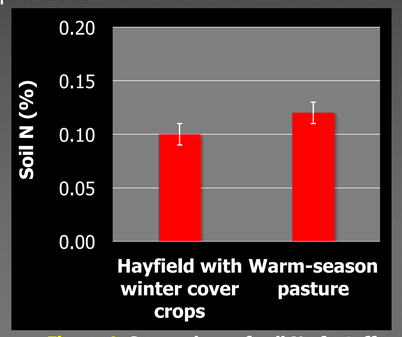

Figure 4. Comparison of soil N of a teff hayfield following winter cover crops to a pre-existing warm-season grass pasture.

There was a significant interaction between winter irrigation, tillage, and forage ($P = 0.04$). In addition, all treatments imposed on the teff hayfield reduced the soil C ($P < 0.01$; Fig. 5).

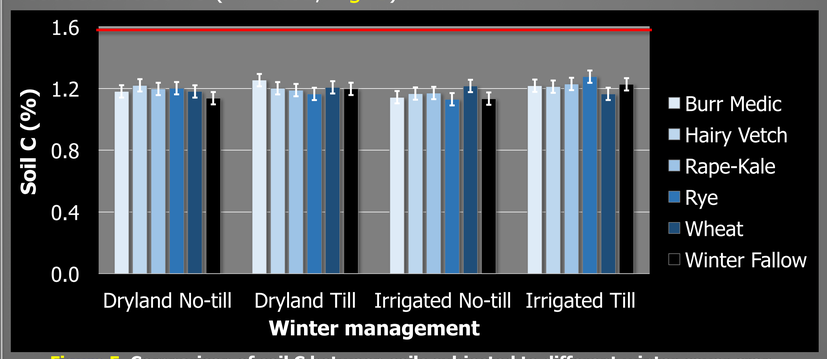

Figure 5. Comparison of soil C between soils subjected to different winter cover crop management strategies. The red line represents the soil C of the pre-existing warm-season grass pasture.

Even though the imposed management schemes reduced soil POM + sand from the existing warm-season pasture, irrigating the winter cover crop has increased soil POM + sand ($P < 0.01$; Fig. 6). Irrigating the winter crop resulted in lower yields in the subsequent teff crop ($P < 0.01$; Fig. 7).

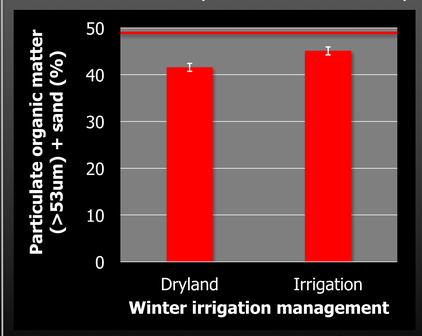

Figure 6. Comparison of POM + sand among soils subjected to different winter irrigation regimes. The red line represents the status in the pre-existing warm-season grass pasture.

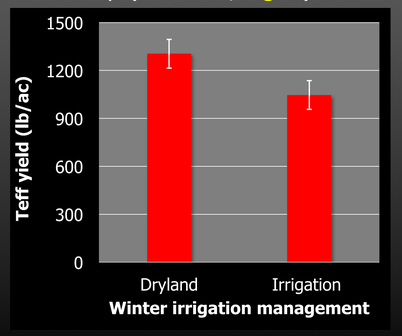

Figure 7. Comparison of teff yield between winter dryland and irrigated crops.

Discussion

- Winter management strategies did not changed the BD of the soil in the teff hayfield compared to the initial warm-season grass pasture (Fig. 3; $P = 0.80$). If this research continues, it is expected that that BD of the soil in the no-till treatments will decrease because of less traffic in the field.
- Although no differences existed among winter management strategies, managing the land as a hayfield did decrease the soil N (Fig. 4; $P = 0.01$). This suggests more N was removed from the hayfield than replaced with fertilization.
- Winter forage species, tillage, and irrigation interacted to affect soil C (Fig. 5; $P = 0.04$). Regardless of winter management, soil C in all plots was less than observed in the pre-existing warm-season grass pasture because soil C was lost when the entire hayfield was tilled at the beginning of the project. Continuing the no-till treatments should allow soil C to increase again.
- The initial tillage and strong winds in the region also reduced the POM + sand (Fig. 6; $P < 0.01$) . However, irrigating the winter cover crops translated to increased forage mass (data not shown) and likely increased root development which increased POM + sand (Fig. 6; $P < 0.01$).
- Neither winter cover crop species nor tillage regime affected forage yield ($P > 0.10$). Surprisingly, plots that were irrigated over winter resulted in lower teff yields than those managed as dryland (Fig. 7; $P = 0.04$). Since the winter irrigated crops produced more forage mass, it is possible they also extracted more soil water.

Implications and Future Work

- The impact of this project is three-fold:
  1. Strengthen rural communities by ensuring the persistence of profitable agriculture in the region,
  2. Stabilize the soil surface from excessive wind erosion and desiccation,
  3. Improving soil C and N stocks and accessible pools for microbially mediated nutrient cycling.
- Future work will focus on completing the characterization of POM in the research plots and better understanding microbial community dynamics that interact with these winter cover crop management strategies evaluated in this research.

Conclusion

To better understand the impact of winter cover crops on soil characteristics, research should be continued to allow time for these parameters to more accurately reflect the management regimes in place.

References

Baxter, L.L. and C.P. West. 2017. Evaluation of winter annual cover crops under multiple residue managements: Impacts on soil water depletion and cash-crop productivity. American Forage and Grassland Conference, Roanoke, VA. 24 Jan.

NRCS. 1996. Soil Survey Laboratory Methods Manual. Accessed 17 Apr. 2017. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/nrcs143_019356.pdf

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