Impacts of Winter Cover Crops on Soil Respiration in the Rio Grande Valley

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INTRODUCTION

Soil degradation is a major obstacle to long-term sustainability in agriculture. An estimated 40% of agricultural lands have been adversely impacted by human-induced soil degradation (Oldeman 1992). Cover crops are often cited as one appropriate and effective method to restore soil health. Soil respiration is one of the NRCS-recognized indicators of soil health that can be promoted by soil management practices like cover cropping. Soil respiration refers to the carbon dioxide (CO_2) that diffuses out of the soil due to the biological activity of microorganisms, insects, plant roots, and other soil life (USDA/NRCS 2009).

The Lower Rio Grande Valley in subtropical Texas is one of the primary agricultural regions of Texas, especially for vegetable production, yet cover cropping to encourage soil health remains an uncommon practice (Masabni and Dainello 2009). Dryland cover crop trials currently underway at Hilltop Gardens in Willacy County, one of the 4 southernmost counties of Texas, examine the impact on soil health of four different winter season cover crop treatments.

EXPERIMENT DESIGN

- November 2017 - five treatments were seeded in a100m x 400m field using a randomized block design with 5 replications
- Treatments included crimson clover, hairy vetch, forage pea, a 50/50 mix of forage pea and triticale, and a control; clover, vetch, and pea seeds were inoculated with rhizobium on the planting date

Crimson clover (*Trifolium incarnatum*)

Hairy vetch (*Vicia villosa*)

Forage pea (*Pisum sativum*)

Forage pea/triticale (*P. sativum/Triticale hexaploide*)

Control
Left unseeded; Common weeds include pigweed and nutsedge

- A Li-Cor 6400XT portable gas exchange system with a soil chamber attachment was used to collect soil CO_2 efflux rates in each plot every 2-3 weeks from seeding to termination
- 4 PVC soil collars were installed in each block 24 hours before measurements began and remained in place for the duration of the season
- Due to longer than expected measurement times, Dec. 13 data includes 1 replication/block. Jan. 3-4 and 22-23 data includes 2 replications/block (1 recorded each day)
- Soil temperature and moisture readings using a Decagon Pro-Check meter were also recorded
- These measurements will continue through mid-February when the cover crops will be terminated and the field prepared for a March sorghum planting

RESULTS

Figure 1 – The middle picture above shows one replicate of the five treatments in the research field approximately 75 days after cover crop seeding. The corner pictures show closer views of the four cover crops, also 75 days after seeding.

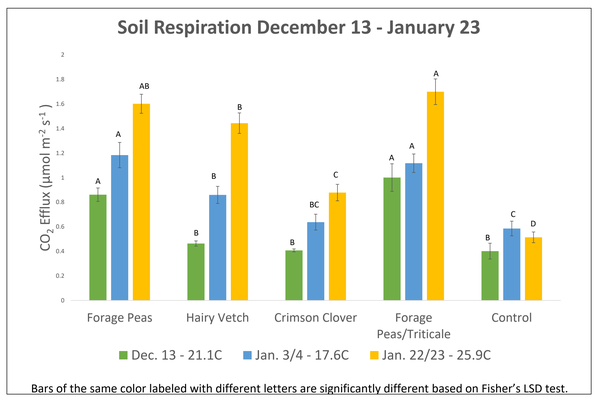

Figure 2 –As expected, the four cover crops show consistent increases in soil respiration over time. On all 3 measurement dates, forage peas and forage peas/triticale showed the highest efflux rates. However, the other three treatments did shift in performance over time. In the Dec. 13 measurements, the clover, vetch, and control all had low efflux rates that did not significantly differ. On Jan. 3-4, vetch showed significant efflux increases over the control. Clover's efflux rested in between vetch and control, not significantly different from either. In the final Jan. 22-23 measurements, hairy vetch showed continued improvement and moved within the range of significance for forage peas. Clover was still higher than the control, but lower than all other cover crop treatments.

Figure 3 – On left, graduate researcher Habraham Lopez installs a PVC soil collar for use with the Li-Cor soil chamber. These were installed 24 hours before the first measurements to reduce the impact of soil disruption. The middle picture shows the Li-Cor 6400 XT measuring CO2 efflux in a plot of forage peas. On right, farm manager Andy Cruz and graduate researcher Stephanie Kasper look over temperature, moisture, and efflux data together and discuss preliminary trends while waiting for the Li-Cor efflux measurements, which take about 10-12 minutes each to conduct.

DISCUSSION

Preliminary results suggest that all four cover crop treatments increase soil respiration levels over the control. More detailed data on biomass will be collected at cover crop termination. However, field observations indicate that the largest cover crops with the most above-ground biomass – forage peas and the forage pea/triticale mix – show the greatest gains in soil respiration. Their above-ground biomass is likely supported by more extensive root structures which contribute greatly to total respiration. The larger plants may also produce more sugary root exudate, a food source for microbial communities which contribute to respiration (Taiz 2015). Hairy vetch has less above-ground biomass, yet its respiration, especially in the most recent measurement set, is still high. This suggests a particularly large and active root system. Crimson clover, the slowest grower of the four treatments, shows correspondingly low respiration levels.

Although the soil respiration measurements are promising, a single indicator is an insufficient measure of cover crop success and overall soil quality. A clearer picture of the impacts of the cover cropping will be developed through the collection and analysis of additional data discussed below. This project is a participatory research project driven by our farmer partners at Hilltop Gardens. From an economic standpoint, they are interested not only in the principles of soil health but also in the practical impacts that improving soil health might have on sorghum yields. The utility of this cover cropping technique to medium and large grain farmers in the Rio Grande Valley is a major focus of the project that will be better assessed with yield data at the end of the sorghum season.

FUTURE WORK

- Two more sets of respiration measurements will be conducted before cover crop termination and sorghum planting in early March
- At termination, final cover crop biomass for each treatment and information on weed suppression will be assessed
- Soil respiration will be combined with data on other soil properties to acquire a more complete picture of the impact of cover cropping on soil health
  - Physics – bulk density, infiltration, compaction, aggregate stability
  - Chemistry – nutrient levels, pH
  - Biology – organic matter, microbial communities, weed seed bank
- Data on sorghum growth and final yields will be collected and combined with records on the input and labor costs of each treatment to construct enterprise budgets that address the economic viability of each of the cover crop options
- Trials will continue at this location in Summer 2018 aiming to expand the list of cover crop options suitable for the extreme summers in the Rio Grande Valley

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