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Living Soil for a Sustainable Future: Cover Crop Effects on Soil Health and Productivity

Introduction

The agricultural advancements of the past 60 years have brought on new challenges for the interaction between agriculture and the environment. Nutrient overloading and runoff from agricultural activities has led to polluted groundwater systems, eutrophied waterways, and aquatic "dead zones." Increasing uncertainty brought on by climate change and potential freshwater shortages calls on use to ensure that our current and future farming practices protect the vital ecological resources of the natural world.

Farming techniques such as the use of cover crops that capitalize on natural biological nutrient cycling processes may help to decrease input costs, increase yields, and improve environmental sustainability.

The purpose of this study was to examine the effects of cover cropping on the soil biological and chemical features that contribute to soil fertility and subsequent fall crop growth. The study looked at two summer cover crops – cowpea (*Vigna unguiculata*) and sorghum-sundangrass (*Sorghum bicolor*) in comparison with no-cover control – and their effects on soil respiration, soil organic matter and nitrogen availability, and fall lettuce production under black plastic mulch. Cowpea was chosen for its ability to form a microbial-plant relationship with high nitrogen-fixing bacteria. Sorghum-sudangrass was chosen for its expected high biomass input.

Sorghum-sudangrass (front and back) and cowpea (far left) summer cover crops.

Results

Soil Fertility

- Both cover crops increased soil organic matter, total organic carbon, potassium, and magnesium by over 20%, 21%, 27%, and 35%, respectively, compared to the no-cover crop control.
- No differences in C/N ratio.
- Cowpea increased extractable soil nitrate by 97% compared to the no-cover crop control. In contrast, sorghum-sudangrass decreased extractable soil nitrate concentration to 21% of the control no-cover crop control.

Soil Respiration

- Cowpea increased field soil respiration rate by three fold compared to the no-cover crop control.
- In contrast, the increase in soil respiration with sorghum-sudangrass was not different from the control.
- Using soil samples taken from the in-field experiment, a parallel laboratory aerobic incubation study to determine nitrogen released over 5 weeks was conducted. Similar to the field soil respiration, cowpea released the greatest amount of nitrate during the 5 week incubation period. In contrast, sorghum sudangrass released less nitrate than the no-cover crop control in weeks 1 and 2, and similar to the control in weeks 3 and 5.

Lettuce Production

- Lettuce growth and production as measured by both fresh weight and leaf area were reduced after sorghum-sudangrass, but were not different between cowpea and the control. This difference is in agreement with the soil extractable nitrate.

Plant Tissue & Soil Nutrient Analysis and Lettuce Yield

Cover Crop	Tissue Biomass ($Mg*ha^{-1}$)	Tissue Total N ($kg*ha^{-1}$)	Soil OM[x] (%)	Soil TOC (%)	Soil NO_3 (ppm)	Soil Resp. Rate[y]	Lettuce Yield ($Mg*ha^{-1}$)	Lettuce Leaf Area (cm^2)
Cowpea	8.1 b[z]	227 a	1.23 a	0.72 a	9.3 a	314 a	1.73 a	610 a
Sorghum	22.1 a	286 a	1.17 a	0.68 a	1.0 c	277 ab	0.27 b	136 b
No Cover	1.4 c	19 b	0.97 b	0.56 b	4.7 b	101 b	1.73 a	658 a

[x] OM = organic matter, TOC = Total Organic Carbon, Soil NO_3 = extractable soil nitrate
[y] Soil Respiration Rate (kg CO_2 * ha^{-1} * d^{-1})
[z] All numbers within a column followed by the same letter are not statistically different at a probability level of 0.05.

Fall lettuce growth after summer cover crops: sorghum-sudangrass (front) and cowpea (back).

Conclusion

In conclusion, the study found that sorghum-sudangrass and cowpea both increased soil organic matter, but only cowpea increased extractable inorganic N, and that sorghum-sudangrass made nitrogen unavailable and was detrimental for fall lettuce production under plastic mulch in the Eastern Shore of Virginia.

While studies of the soil microbial community are still in progress, the preliminary results of this study could be used to influence further research into the benefits of cover crops as they relate to soil health, agricultural production, and the structure and functioning of the soil microbiome.

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