UNDERSTANDING NITROGEN DYNAMICS AND ITS FATE IN INORGANIC FORMS IN SANDY SOILS UNDER A COVER CROP SYSTEM IN FLORIDA

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INTRODUCTION

- Nitrogen (N) is vital for physiological and biochemical functions in the internal plant structure.
- Most of the agricultural soils in Florida are sandy with intensified inorganic fertilizer application schemes to improve soil nutrient availability (Wang and Alva, 2000).
- **20-80%** of applied chemical elements in fertilizer amendments to sandy soils end up in adjacent water bodies (Matichenkov et al., 2020).
- Florida continues to experience water quality impairments from excess nutrient pollution, especially from N and phosphorus (FDEP, 2014).
- Major N losses are by leaching, volatilization, soil erosion and stormwater runoff from agricultural and urban areas.
- The incorporation of cover crops in agricultural cropping systems may be considered a solution to reduce this problem because of their ability to absorb residual N as well as reducing the fertilizer requirement.

OBJECTIVE

Overall Objective: To increase the understanding of soil inorganic N cycling in sandy soils with cover crops and to examine how cover crops influence soil N fertility and crop yields.

Hypothesis: **(i)** Fields with cover crops will maintain a higher soil N concentration compared to fields without cover crops;

(ii) Soil N concentrations under cover crops will increase with soil depth because of N leaching in sandy soils.

TREATMENTS

Sunn hemp (SH)
Scientific name: Crotalaria juncea

Sorghum sudangrass (SS)
Scientific name: Sorghum bicolor

50/50 mixture of Sunn hemp and Sorghum sudangrass (MX)

Weed fallow (control) (CT)

Sunn hemp

- Grows 4-6 feet within 60 days
- Good adaptability to soils with pH 5-7.5
- Leguminous crops i.e can fix atmospheric N into the soil
- Dry Biomass production is more than 5,000 lbs per acre

Sorghum sudangrass

- Tolerant to low fertile, high alkaline and moderate acidic soils
- High tolerance to dry conditions
- Grows an aggressive and eminent root system
- Dry Biomass production is 4,000-5000 lbs per acre

METHODS

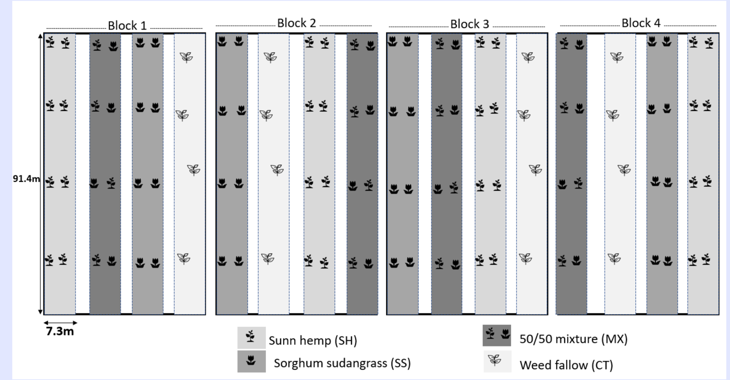


Figure 1: Experimental layout showing the different treatments, each treatment plot measures 24 x 300 feet, number of replications=4

1. Soil sample collection

Figure 2: Collection of soil samples

Cover crops planted in mid April of 2021, soil cores in segments of **0-15 cm**, **15-30 cm** and **30-60 cm** were collected biweekly from each plot.

2. Soil extractions

Soil samples are extracted using 2M KCl and filtered

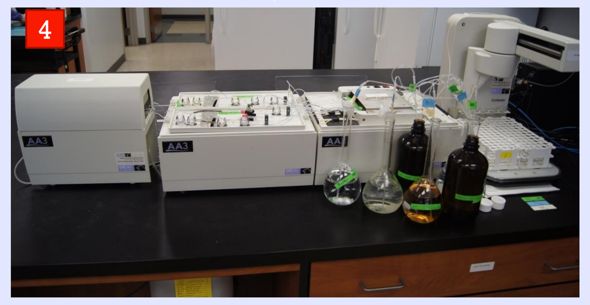
3. Soil incubation

Before and after killing the cover crops, 10 g of soil for each treatment were incubated aerobically for 14 days to measure net N mineralization and nitrification i.e determine rates of soil N production.

Samples extracted and then analyzed

4. Soil nutrient analysis

Samples were analyzed for KCl exchangeable NO_3^-+NO_2^- and NH_4^+. The NO_3^-+NO_2^- were analyzed by the Copper-Cadmium reduction method where NO_3^- are reduced to NO_2^- by the cadmium column while the NH_4^+ was analyzed by the Salicylate method.



5. Plant tissue collection

Figure 3: Preparation of SH plant tissue for analysis

After 97 days , the cover crops were killed, and biomass were collected within 1.0 m² using the Harvest method (SERAS, 1994).

The plant tissues were dried by solarization, and total dry matter was calculated.

Plant sample tissues were also analyzed for total N and Carbon.

RESULTS AND DISCUSSIONS

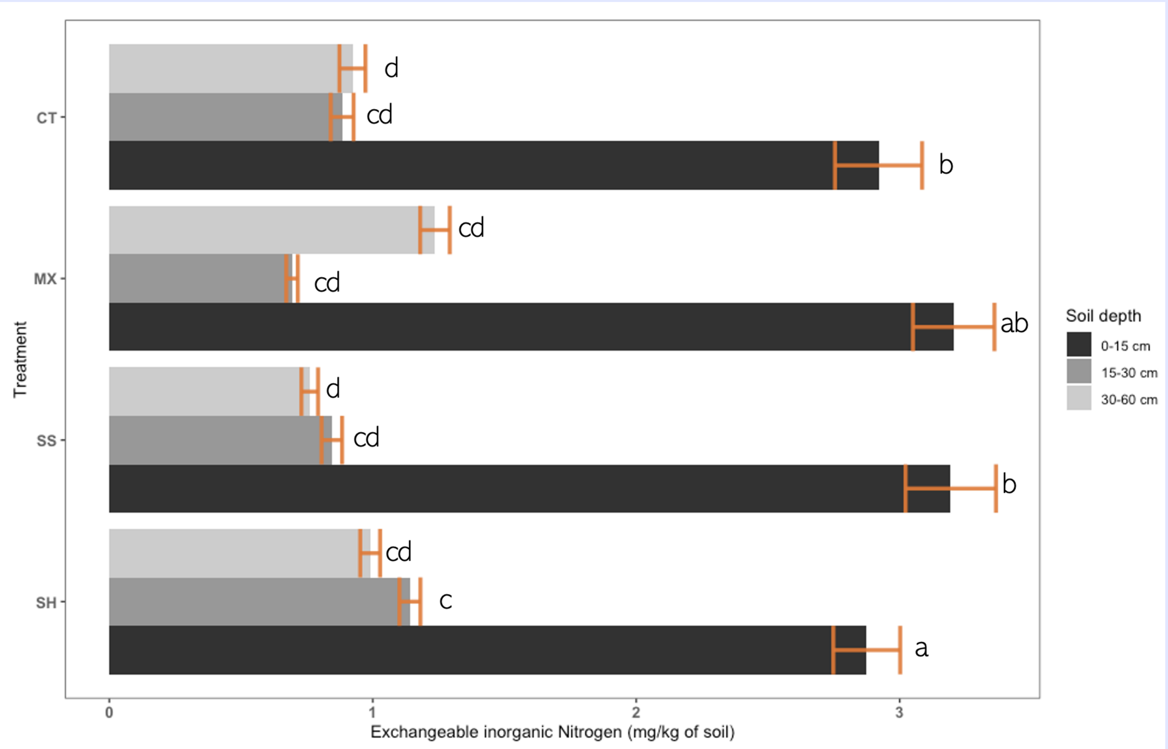


Figure 4: Comparison of concentrations of exchangeable inorganic N (NH_4^+ + NO_3^-+NO_2^-) across the treatments with the three depths: Different letters indicate significant difference.

- Inorganic N concentration was highest in the surface soils (0-15 cm) and there were significant differences between SH with SS and CT although no significant differences were obtained between SH and MX treatments (Figure 4).
- Generally, exchangeable inorganic N reduced significantly with increasing soil depths with exceptions of MX and CT which had slightly higher N concentrations in the 30-60 cm depth than the soil surface.
- The lower concentration of N in the SH especially in the soil surface could be related to the vigorous growth of SH where most of the N is sequestered in its large biomass (Wang et al., 2005).

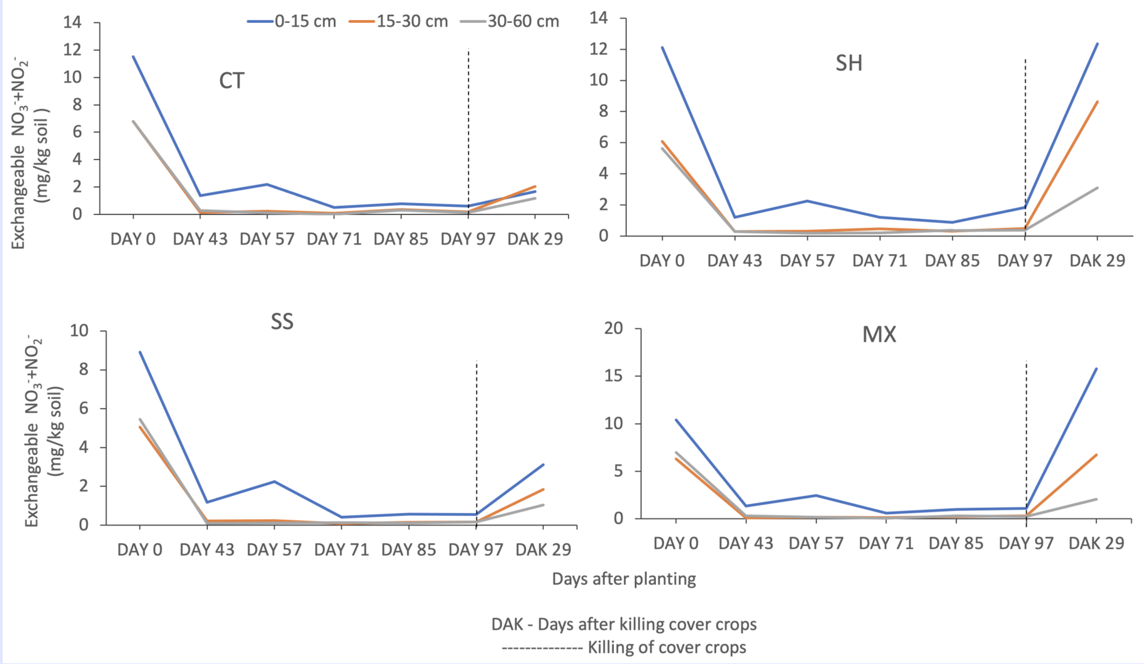


Figure 5: Exchangeable NO_3^-+NO_2^- availability in different depths compared with time from DAY 0 (first day of cover crop planting) to DAY 97 (when the cover crops were killed). DAK 29 marks 29 days after killing cover crops and leaving them to decompose naturally.

- Nitrates are considered highly mobile because of their high solubility and negative charge, which makes them more prone to leaching (EPA, 2016).
- At 29 days after killing the cover crops, surface soil nitrate levels were higher in cover crop treatments than in the control soils (Figure 5), showing that the cover crops added N to the soil, which may improve soil fertility and reduce fertilizer needs.
- Nitrate levels in the deepest soils were not higher under cover cropped soils than for control soils, showing that at 29 days after the cover crops were killed there was little loss of N via leaching.

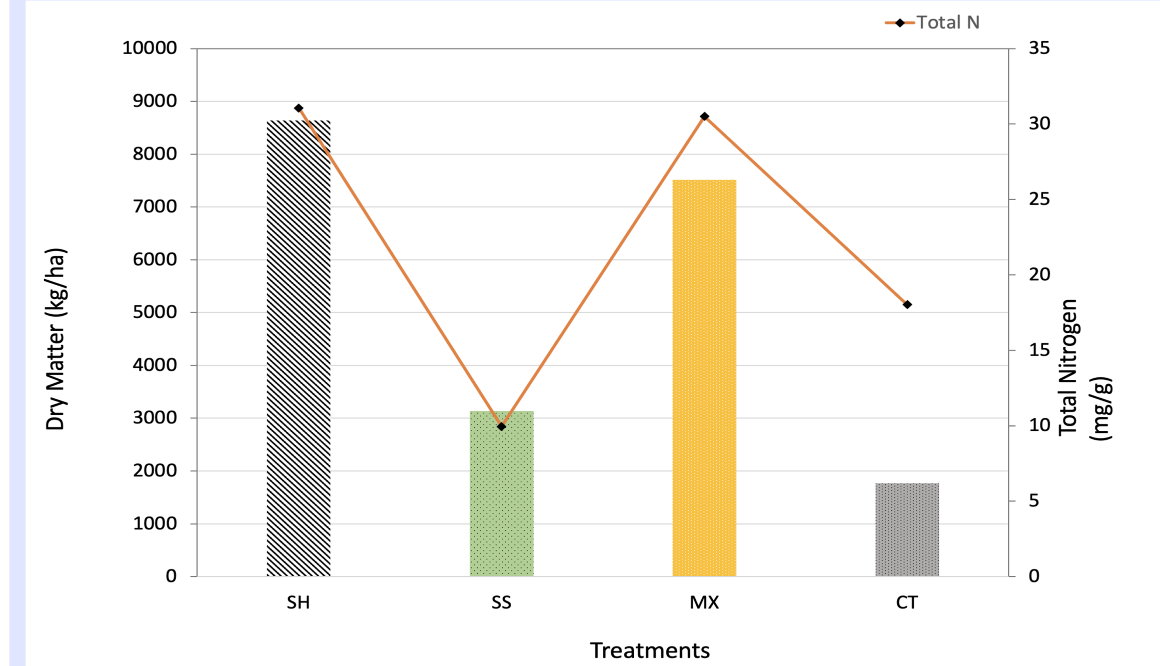


Figure 6: Comparison of production of dry matter and total N across the treatments

- SH produced the highest amount of dry matter (DM) of 8460 kg/ha followed by the MX, SS and CT (Figure 6).
- A similar trend was also seen with the analysis of total N where SH produced the highest value of 31 mg/g of DM.
- SH could be adding N to the to the already available soil N by fixing atmospheric N which is later incorporated into the plant biomass (Wang et. al 2019).

CONCLUSION

- Exchangeable inorganic N was highest in the 0-15 cm.
- The SH and MX cover crop treatments added the most inorganic N to the surface soils, and by 29 days after killing the cover crops, this inorganic N showed little sign of leaching loss. Future research will continue to monitor potential N loss with greater time.
- Sunn hemp (SH) produced the highest dry matter and total N in its biomass which may indicate that SH may have a higher N contribution to the soil than the other treatments.
- Cash crop (squash and tomatoes) were grown in the fields where the cover crops were planted. On going data collection is being carried out to assess the effect of the cover crop on the cash crop yield.

REFERENCES

- Florida Department of Environmental Protection (FDEP). (2014, April). *Integrated Water Quality Assessment for Florida: 2014 Sections 303(d), 305(b), and 314 Report and Listing Update*. FDEP. https://floridadep.gov/sites/default/files/2014_integrated_report.pdf
- Matichenkov, V., Bocharnikova, E., & Campbell, J. (2020). Reduction in nutrient leaching from sandy soils by Si-rich materials: Laboratory, greenhouse and filed studies. *Soil and Tillage Research*, *196*, 104450. https://doi.org/10.1016/j.still.2019.104450
- US Environment Protection Agency. (2006). *Nitrates and Nitrites*. EPA. https://archive.epa.gov/region5/teach/web/pdf/nitrates_summary.pdf
- Wang, Q., Li, Y. C., Klassen, W., & Hanlon, E. A. (2019). Sunn Hemp: a Promising Cover Crop in Florida. *EDIS*, *2015*(7), 4. https://doi.org/10.32473/edis-tr003-2015
- Wang, Q., Li, Y., & Klassen, W. (2005). Influence of summer cover crops on conservation of soil water and nutrients in a subtropical area. *Journal of Soil and Water Conservation*, *60*(1). https://www.jswconline.org/content/60/1/58.
- Wang, F. L., & Alva, A. K. (2000). Ammonium Adsorption and Desorption in Sandy Soils. *Soil Science Society of America Journal*, *64*(5), 1669–1674. https://doi.org/10.2136/sssaj2000.6451669x

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