National Soil Dynamics Laboratory

Highlights

Fall 2021

United States Department of Agriculture

Agricultural Research Service

Determining the Best FGD Gypsum Application Practice to Reduce P loss from Agricultural Fields

Phosphorus loss from agricultural fields is a major contributor to surface water eutrophication. Manure applications based on crop N demand can exacerbate these losses. Previous research from NSDL, as well as other research facilities have shown that gypsum is very effective at reducing soluble P losses from soils following manure applications. As a result, gypsum is being promoted as a soil management tool to reduce soluble P losses in surface water runoff from agricultural fields. For example, the USDA–NRCS has a National Conservation Practice Standard for maintaining soil quality and reducing the risk of P runoff from manure applications. Alabama has included gypsum use into its "P Index" guidelines for determining P runoff risks in specific fields, and the Alabama Cooperative Extension System has recommended gypsum a best management practice for P reductions.

Figure 1. A look inside of the rainfall simulator during an artificial rainfall event.

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Figure 2. A picture of runoff plots used to evaluate different agricultural field management scenarios.

Dynamically Speaking

H. Allen Torbert
Research Leader

Work continues at the National Soil Dynamics Laboratory (NSDL) under "maximum teleworking" status due to the COVID-19, but we are managing to get research accomplished. With the help of vaccinations, we are looking forward to all of us being back at the lab in the next few months. In the last few years we have had increased funding to expand our research efforts to develop sustainable agriculture production systems and I am glad to announce that we have been able to move forward with hiring new staff. Therefore, in this letter, I would like to welcome Cami Shands to our laboratory technical support staff and Wendy Counts to our administration support staff. In addition, while not new to NSDL, I would also like to welcome to their new roles Barry Dorman as Facilities Operation Specialist and Trent Morton as our Economist.

I hope you enjoy reading about some of the research efforts we have included in this issue of National Soil Dynamics Highlights, and please visit our web site for more information about our ongoing projects.

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... FGD Gypsum cont.

Recently the question has been raised, "What is the best application method for reducing P loss with gypsum application?" The current recommended practice is to apply the gypsum on top of the manure before a rainfall event. Is this the most effective practice for optimizing P reductions from agricultural fields? Could manure be placed on top of the gypsum (gypsum applied first) or should it be mixed? In addition, what happens if a rainfall event occurs after gypsum application, before the manure is applied?

Our lab has teamed up with the USDA-ARS National Soil Erosion Laboratory in Indiana to evaluate these questions. A series of rainfall simulation studies were conducted to evaluate the influence of these management practices on the potential for P and sediment loss with surface runoff under different rainfall intensities and timing in a no-till and conventional till system. Given that land practitioners are continually being charged with improving soil and crop productivity while minimizing agriculture's influence on the environment, we believe results from this study could improve current management prescriptions to help safeguard our water quality.

Figure 3. Picture of a runoff flume at the downslope end of a plot.

Direct Greenhouse Gas Emissions from a Pilot-Scale Aquaponics System

Aquaponics, the practice of combining aquaculture and hydroponics, has the potential to reduce environmental impacts of food production by repurposing aquaculture wastewater for hydroponic crop production. Agricultural production systems are known to be large contributors to global greenhouse gas (GHG=CO2, CH4, N2O) emissions; however, little attention has been given to GHG emissions from non-traditional systems such as aquaponics. In a collaborative effort with the Departments of Biosystems Engineering and Horticulture and the School of Fisheries,

Upcoming Events 2021/2022

Dates	Meeting	Location
Nov. 7-10, 2021	Agronomy, Crop Science, & Soil Science Societies' Annual Meeting	Salt Lake City, UT/ Virtual
Jan. 6-9, 2022	Southeast Vegetable and Fruit Expo	Savannah, GA
Jan. 4-6, 2022	Beltwide Cotton Conf	San Antonio, TX
Jan. 24-27, 2022	Southern Weed Science Society of America Annual Meeting	Austin, TX
Feb. 12-14, 2022	Southern Branch-ASA Meeting	New Orleans, LA
Feb. 10-15, 2022	Southern Association of Agricultural Scientists Annual Meeting	New Orleans, LA
Jan. 31-Feb. 2, 2022	25th Annual National Conservation Systems Cotton & Rice Conference	Jonesboro, AR/ Virtual

Aquaculture & Aquatic Sciences at Auburn University, we determined direct GHG emissions from a pilot-scale aquaponic facility. We also determined how emissions from unit operations differ based on a set of environmental and operational parameters. Major unit operations included a biofloc fish tank stocked with tilapia, a biosolid settling clarification system, and a climate-controlled greenhouse in which cucumber plants were grown in a substrate culture. The study was separated into three seasons. In the summer of 2019, different pH treatments for cucumber irrigation water were tested. In the fall of 2019 and winter of 2020, perlite vs. pine bark substrates were tested for cucumber production. Measurements indicated differences in GHG emissions between areas of the fish tank receiving high-intensity vs. low-intensity aeration. High CH_4 emissions from the clarification system indicated anaerobic activity. Results from plant production showed significant relationships with various selected parameters with pH having a negative correlation with N_2O efflux and pine bark averaging higher CO_2 efflux values compared to the perlite substrate. This study provides insight into management practices that may reduce direct GHG emissions from aquaponics systems. Findings from this study shed light

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... Greenhouse Gas cont.

on how operational variables can affect direct GHG emissions from an aquaponics facility. Based on our results, we recommend the use of non-organic substrates (i.e., perlite) for plant growth to reduce CO_2 emissions. Likewise, we also recommend avoiding the addition of citric acid or other organic carbon sources to prevent additional N_2O production and denitrification. Within clarifiers, we suggest implementing a faster separation process with frequent solid removals to avoid anaerobic conditions and reduce CH_4 emission. Information from this study will aid in calibrating a mass-balance process model to track nutrient flows under changing operating conditions. Most importantly, this study will allow for a basic framework to quantify direct GHG emissions from other types of aquaponics systems.

Figure 4. Aerial view of the aquaponics facility.

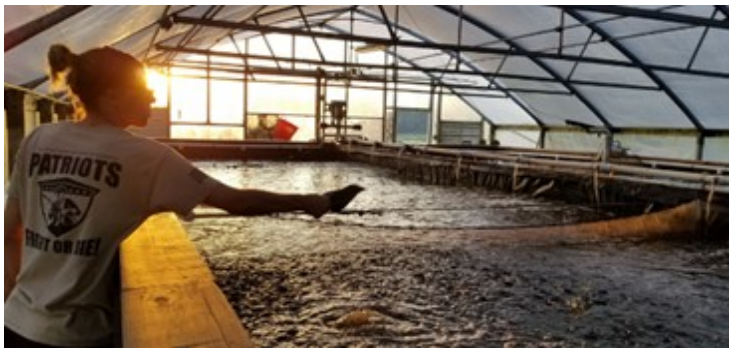

Figure 5 & 6. The biofloc fish tank stocked with tilapia (above) and the climate-controlled greenhouse in which cucumber plants were grown in a substrate culture (below).

Recent Publications

All of our publications are available on our web site: http://www.ars.usda.gov/sea/nsdl

Iboyi, J.E., Mulvaney, M.J., Balkcom, K.S., Seepaul, R., Bashyal, M., Perondi, D., Leon, R.G., Devkota, P., Small, I.M., George, S., Wright, D.L. 2021. Tillage system and seeding rate effects on the performance of Brassica carinata. Global Change Biology. 13:600-617. https://doi.org/10.1111/gcbb.12809.

Price, A.J., Nichols, R., Morton, T.A., Balkcom, K.S., Li, S., Grey, T. 2021. Effect of cover crop biomass, strip-tillage residue width, and pre-herbicide placement on cotton weed control, yield, and economics. Weed Technology. 1-31. https://doi.org/10.1017/wet.2021.8.

Kavetskiy, A.G., Yakubova, G.N., Sargsyan, N., Prior, S.A., Torbert Iii, H.A. 2021. Neutron stimulated gamma ray measurements for chlorine detection. Inst of Electrical and Electronic Engineers Transactions of Nuclear Science. 68(7):1495-1504. https://doi.org/10.1109/TNS.2021.3086327.

Bhatta, A., Chakraborty, D., Prasad, R., Shaw, J., Lamba, J., Brantley, E., Torbert III, H.A. 2021. Suitability of mehlich 3 as a universal soil test extractant for phosphorous loss risk assessment for diverse soil regions. Agrosystems, Geosciences & Environment. 4(3):e20187. https://doi.org/10.1002/agg2.20187.

Watts, D.B., Runion, G.B., Torbert III, H.A. 2021. Influence of FGD gypsum on P loss from a horticultural growth medium. Horticulturae. 7(7):199. https://doi.org/10.3390/horticulturae7070199.

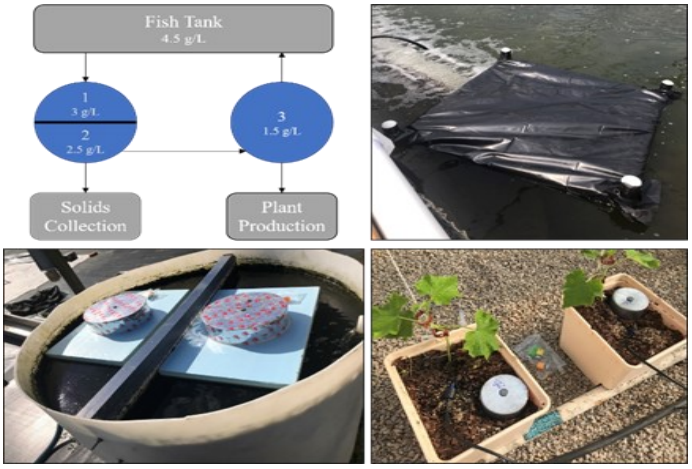

Figure 7. The general flow through the aquaponics system. Water from the fish tank recirculates through a 3 -stage clarifier (blue), which removes suspended solids. From there, clarified water either returns to the fish tank or is pumped to the greenhouse for irrigation use. Photographs showing GHG collection equipment: the inflatable bag used in the fish tank; the floating fixed-headspace rafts used in the clarifiers; and the gas flux chambers placed on the plant growth substrate in Dutch buckets.

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Agronomic Guidelines for Carinata Production

Carinata is a potential biofuel crop suited for growth over winter months in the Southeast. The winter period is a favorable time to grow a biofuel crop because competition with summer crops is eliminated. The period also creates a natural rotation between summer crops and a biofuel crop. This rotation complements existing cropping systems with another potential revenue source during a period not traditionally used by growers for extensive revenue generation.

However, minimizing production costs are essential to maintain a level of profitability attractive to growers, which will incentivize them to produce a given crop. Reducing tillage by adopting some form of conservation tillage is one way to reduce production costs, while preserving soil health benefits. The level of tillage required and corresponding seeding rates for different tillage systems is unknown to optimize carinata production. Therefore, researchers at NSDL and the Univ. of Florida conducted a study to evaluate yield performance across different tillage systems and seeding rate combinations.

Tillage treatments (conventional tillage; broadcast/disc; non-inversion tillage; no tillage) were chosen to provide different levels of surface disturbance, resulting in different levels of surface residue remaining (Fig. 1). Four carinata seeding rates (1.0, 5.0, 9.0, and 13.0 lb/ac) were drilled across each of the tillage systems. Five site-years were examined across Jay, FL, Quincy, FL, and Shorter, AL. The previous crop was cotton across all site-years.

Figure 8. Non-inversion tillage implement to minimize surface disturbance and maximize belowground disruption.

No consistent yield effect was measured across tillage treatments. This could be attributed to inconsistent growing seasons (i.e. wet or dry) across the five site-years of the experiment. Seeding rate effect on yield was consistent across all site-years. Carinata yield was lowest for the lowest seeding rate, while yields were equivalent among the other seeding rates across all site-years. No interaction was observed between tillage system and seeding rate. These results indicate that 5.0 lb/ac is the recommended seeding rate, regardless of tillage system. These results provide some general agronomic information about carinata production to growers interested in incorporating this crop into their cropping systems.

Happenings

Dr. Kip Balkcom was invited to present at the Alabama Extension sponsored 2021 South Alabama Cover Crop Field Day. The title of his presentation was Nitrogen Credit from Legume Cover Crops. Only 25 people were invited and COVID guidelines with respect to social distancing and masks were enforced. The event was also outside. Participants were farmers, ag industry personnel, extension specialists, and NRCS personnel. 3/3/2021

Dr. Kip Balkcom was invited to present at the 2021 Alabama Precision Agriculture Webinar series sponsored by Alabama Cooperative Extension. The title of his presentation was Nitrogen Credit from Legume Cover Crops. The event was broadcast on Facebook Live and is also available for viewing on demand at https://www.facebook.com/AlabamaPrecisionAgOnline/videos/168025961801914 3/17/2021

Dr. Kip Balkcom was invited to present at the Univ. of Florida Extension sponsored Cover Crop and Soil Moisture Field Day in McDavid, FL. The title of his presentation was Cover Crop Management. Less than 25 people were invited and COVID guidelines with respect to social distancing and masks were enforced. The event was held outside. Participants included farmers, ag industry personnel, and extension specialists. 4/22/2021

Dr. Kip Balkcom was invited to present at the 2021 National Cooperative Soil Survey Virtual Meeting hosted by Auburn Univ. Dr. Balkcom's presentation was titled Conservation System Research. He provided a history of the National Soil Dynamics Lab as well as an overview of conservation system research. Approximately 250 people were online for the presentation. Participants represented many different government and state agencies, as well as universities and non-gov orgs interested in soils. 6/10/2021

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