National Soil Dynamics Laboratory

Highlights

Fall 2019

United States Department of Agriculture

Agricultural Research Service

Cereal Cover Crop Response to Nitrogen Fertilizer

A winter cover crop can benefit the soil and/or subsequent crop, but cover crops are not harvested for feed or sold as a commodity (Fig. 1). Cover crop benefits include soil erosion protection, increased soil organic C accumulation, weed suppression, and soil moisture conservation. Coarse-textured, degraded soils found throughout the Southeast can be very receptive to these benefits. In general, benefits improve as surface biomass increases, and surface biomass persistence is extended. Persistence is key because hot, humid conditions in the summer speed up surface biomass decomposition.

Despite benefits, there is a cost for establishing, managing, and terminating cover crops. Coarse-textured soils and high average rainfall amounts combine to limit inorganic N available for uptake so N fertilizer applications can ensure adequate cereal biomass production. Information about expected biomass levels produced from N fertilizer helps growers manage biomass production costs within their cover crop goals.

A four-year experiment (2009-2012) was conducted in Headland, AL. Biomass production for oat, rye, and ryegrass was compared across four N rates (0, 30, 60, and 90 lb N/ac.) applied as ammonium nitrate. All cover crops were established between the 1st and 3rd week of Nov. and terminated between the 2nd and 3rd week of April.

Average biomass production was 5510 lb/ac for 'Wrens Abruzzi' rye, 4230 lb/ac for 'Harrison' oat and 2510 lb/ac for 'Marshall' ryegrass. Average biomass production varied by growing season and differences were attributed to seasonal rainfall and growing degree days. Average biomass production for each species also varied across N rates (Fig. 2). Slopes for each species line indicated rye was 1.2 times more responsive to applied N compared to oat and ryegrass (data not shown).

Nitrogen contents were similar between oat and rye but averaged 53% greater than ryegrass. Nitrogen contents ranged from 22 to 67 lb N/ac. (Fig. 3) across species. A C/N ratio >30:1 indicates N release and decomposition from residues will be slow. Rye (55:1) produced the greatest C/N ratio, followed by oat (44:1), and ryegrass (38:1) indicating each species would decompose slowly. The greatest C/N ratio and superior biomass production observed for rye made rye the most resistant species to

Figure 1. Rye roller operation at termination.

Continued on p.2

Dynamically Speaking

H. Allen Torbert
Research Leader

As we move into Fall, the National Soil Dynamics Laboratory (NSDL) is working hard to collect data from our field experiments and to prepare for planting of winter crops and cover crops as we move forward with these studies. Earlier this year I announced that the NSDL received funding for a new facility for our research, so the planning for this new state-of-the-art facility on the Auburn University campus is moving forward. In this letter, I would like to announce that the US Congress has also substantially increased our base funding for the NSDL to support our research efforts. With this increased support, we plan to reinforce and expand our current research efforts to develop productive and sustainable agriculture production systems.

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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...Cereal Cover Crop cont.

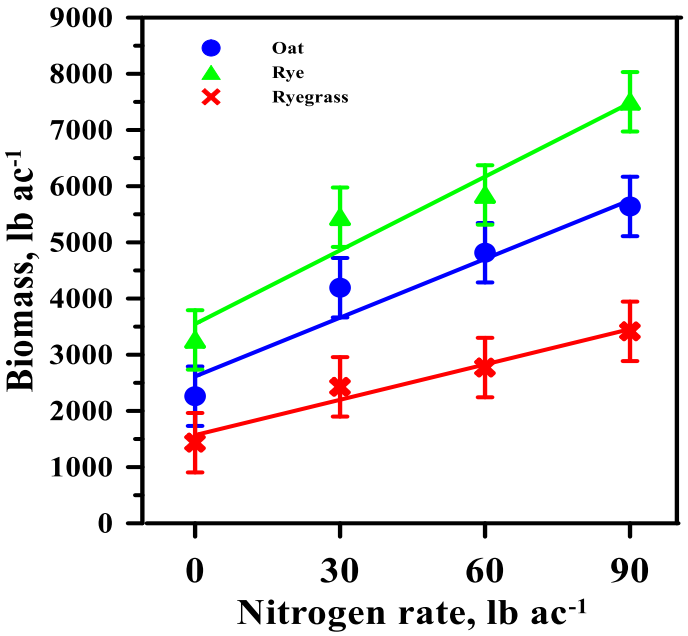

Figure 2. Four-year average biomass production measured across N rates for oat, rye, and ryegrass.

decomposition. This aspect translates into a longer surface protection period compared to oat and ryegrass. Nitrogen uptake efficiency (NUE) averaged 54% and 57% for oat and rye, respectively. Average NUE for ryegrass was 21% due to low N content and biomass production.

Rye and oat performed similarly across N rates, while ryegrass lagged behind for all measured values. Single species winter cereal cover crops like rye and oat benefit from N fertilizer applications by enhancing biomass levels and benefits.

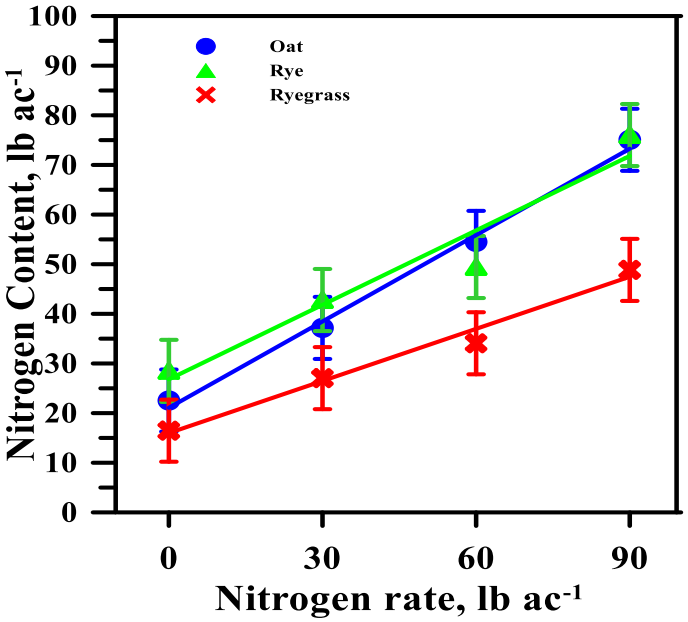

Figure 3. Four-year average N contents measured across N rates for oat, rye, and ryegrass.

Upcoming Events

Dates	Meeting	Location
Nov 10-13	Agronomy, Crop Science, & Soil Science Societies' Annual Mtg	San Antonio, TX
Nov 15-16	AL Fruit & Vegetable Growers Assoc. Annual Conf. and Trade Show	Clanton, AL
Jan 9-12	Southeast Vegetable and Fruit Expo	Savannah, GA
Jan 8-10	Beltwide Cotton Conf.	Austin, TX
Jan 22-25	Southern SAWG Conference	Little Rock, AR
Jan 30– Feb 5	Southern Assoc. of Agricultural Scientists Ann. Mtg	Louisville, KY
Jan 27-30	Southern Weed Science Society of America Annual Mtg	Biloxi, MS
Feb 1-3	Southern Branch—ASA Mtg	Louisville, KY
Feb 7-8	Georgia Organics Annual Conf.	Athens, GA

NSDL and U.S. Army Join Forces to Revitalize Soil with Paper

The NSDL is helping the U.S. military with a solution to two major environmental problems: disposal of paper waste and revegetating damaged training grounds.

Under federal regulations, U.S. Army classified papers must be pulverized to a fine consistency (Fig. 4), which leaves the material unsuitable for recycling. Continued disposal of this waste in landfills presents environmental concerns and is expensive. Army training areas also become barren of vegetation from constant use by heavy equipment and foot soldiers. Soil erosion can occur, making it difficult to reestablish native grasses.

NSDL teamed up with the U.S. Army Corps of Engineers to help address these issues. Their research focused on evaluating the use of pulverized or finely ground paper as a soil amendment to improve soil health and the ability to establish desirable native grasses on degraded army training lands. Pulverized paper, which is like a very fine confetti, is a cheap, high-quality organic material that is useful as a soil amendment. The NSDL worked with the army to determine the correct application rates and to make sure there were no environmental concerns from the application of paper (Fig. 5).

Earlier trials conducted on research plots, located in Fort Campbell, KY and Fort Benning, GA, showed positive results for vegetation restoration where processed waste paper was applied. This recent study, published in *Elsevier* in 2019, on finely ground paper was conducted at Fort Polk, LA.

Continued on p.3

… Soil and Paper cont.

Figure 4. Approximately 1 ton of pulverized paper in a roll-off container.

It demonstrated that adding this type of paper waste to army training grounds improves soil health, increases growth of native grasses, and provides a solution for disposing classified paper waste.

Using the material as a soil amendment also is a big economic win, because native plant establishment was improved, with plant cover 45% higher on sites with the recommended application rate compared to controls. Pulverized paper material applied at the recommended application rate on training grounds resulted in a cost savings of approximately $4,700/ac—an estimated annual cost savings of $20,000 for each military facility —with 70 tons of paper diverted from landfills. There is also an environmental benefit as restoring plant cover protects the soil from erosion, promotes accumulation of soil carbon, and provides improved wildlife habitat.

Paper application rate was positively correlated with native plant cover, deficient plant and soil nutrient concentrations and soil pH, and negatively correlated with invasive plant cover and biomass and soil bulk density. The study showed that pulverized paper can be safely applied to degraded training areas to improve establishment of desirable vegetation without any noticeable negative consequences.

Figure 5. Paper awaiting incorporation and seeding.

Long-term Effects of Elevated Atmospheric CO_2 and Soil Fertility Management on a Bahiagrass Pasture

Pastures represent a significant portion of the rural landscape in the southeastern US, yet remain understudied agro-ecosystems in terms of the effects of rising atmospheric CO_2 concentration. Therefore, we conducted a long-term (10 year) study of bahiagrass (a commonly grown southeastern pasture species) under ambient and elevated (ambient plus 200 ppm) CO_2 on a Blanton loamy sand (Fig. 6). A fertility management treatment was added following a one-year establishment period where half of all plots received N as ammonium suflfate at 80 lb/ac three times yearly plus P, K, and lime as recommended by soil testing; remaining plots received no fertilization. These treatments represent managed and unmanaged pastures, both of which are common in the Southeast. Aboveground forage biomass was harvested 3 times a year (June, August, and October).

Recent Publications

All publications are available on our web site:

http://www.ars.usda.gov/sea/nsdl

Barbosa, J.Z., Motta, A.C., Dos Reis, A.R., Correa, R.S., Prior, S.A. 2019. Spatial distribution of structural elements in leaves of Ilex paraguariensis: Physiological and ecological implications. Trees. https://doi.org/10.1007/s00468-019-01900-y.

Busby, R.R., Torbert III, H.A., Prior, S.A. 2019. Soil and vegetation responses to amendment with pulverized classified paper waste. Soil & Tillage Research. 194. https://doi.org/10.1016/j.still.2019.104328.

Johnson, C., Bailey, A., Way, T.R. 2019. A shearing strain model for cylindrical stress states. Transactions of the ASABE. 62(1):225-230.

Lin, Y., Watts, D.B., Torbert III, H.A., Howe, J.A. 2019. Double-crop wheat and soybean yield response to poultry litter application. Crop, Forage & Turfgrass Management. 5:180082. https://doi.org/10.2134/cftm2018.10.0082.

Rodrigues, A., Motta, A., Melo, V., Goularte, G., Prior, S.A. 2019. Forms and buffering potential of aluminum in tropical and subtropical acid soils cultivated with Pinus taeda L.. Journal of Soils and Sediments. 19:1355-1366. http://doi.org/10.1007/s11368018-2144-7.

Tewolde, H., Shankle, M.W., Way, T.R., Pote, D.H., Sistani, K.R. 2018. Poultry litter band placement in no-till cotton affects soil nutrient accumulation and conservation. Soil Science Society of America Journal. 82:1459-1468. https://doi.org/10.2136/sssaj2018.04.0131.

Watts, D.B., Torbert III, H.A., Codling, E.E. 2019. Poultry production management on the buildup of nutrients in litter. International Journal of Poultry Science. 18(9):445-453. https://doi.org/10.3923/ijps.2019.445.453.

Yakubova, G.N., Kavetskiy, A., Prior, S.A., Torbert III, H.A. 2019. Application of neutron-gamma analysis for determining compost C/N ratio. Compost Science and Utilization. https://doi.org/10.1080/1065657X.2019.1630339.

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... Bahiagrass continued.

Figure 6. Bahiagrass pasture on NSDL soil bin treated with differing levels of atmospheric CO2 using open top field exposure chambers.

Prior to fertility management initiation (establishment phase), biomass was unaffected by CO_2. Overall, results showed that the driest year (2007) had the lowest forage biomass yields while the wettest (2009) had the highest yields, but across the 10-year study there was no consistent pattern relating forage production to air temperature. The effect of fertilizer on forage production was consistently large and highly significant.

However, seasonal (intra-annual) and annual (inter-annual) harvests showed that the effects of elevated CO_2 where lower and less consistent. The overall effect of CO_2 on bahiagrass forage production was typical of responses seen in grass species. The variable response to CO_2 seen among seasonal harvests highlights the importance of conducting long-term studies to capture both intra- and inter-annual response patterns. Overall, there was a strong effect of fertilizer addition on cumulative forage biomass production (~231.8% increase); the overall effect of CO_2 was also significant (~13.8% increase with elevated CO_2). Fertility management by CO_2 interactions showed that CO_2 had no impact on bahiagrass forage production with no fertilizer added (as observed in establishment year); however, forage production was increased (~15.3%) under elevated CO_2 with fertilizer addition.

In conclusion, this study demonstrated that fertilizer addition (primarily N) dramatically increased bahiagrass forage production throughout the 10-year study. Elevated CO_2 also increased forage production, but the effect was lower than fertilizer addition. Results clearly showed that fertilizer was needed to realize an increase from elevated CO_2. These findings highlight the importance of soil fertility management to enhance pasture productivity under rising atmospheric CO_2 levels. This work was recently published in *Soil and Tillage Research*.

Happenings

February 25, 2019, ARS Plant Physiologist, Dr. Andrew Price, National Soil Dynamics Laboratory, Auburn, AL made a presentation titled “Weed Biology and Control Following Winter Cover Crops” at the South Carolina Chapter of the Soil and Water Conservation Society annual symposium held in Columbia, SC.

June 26, 2019, Dr. Kip Balkcom was invited to present at an Alabama Extension sponsored field day about how cover crops and irrigation can work together to improve production for growers. Field day was titled "Irrigation Technologies in Your Hands" and was held in Town Creek, AL with approximately 75 attendees.

July 16-17, 2019, ARS Research Agronomist, Kip Balkcom of the National Soil Dynamics Laboratory, Auburn, AL served as a co-organizer for the 2019 Southern Cover Crop Conference in Auburn, AL. 350 participants attended workshops related to cover crops in the southern US that were organized by various experts. Dr. Balkcom developed a workshop titled “Cover Crop Management Challenges” that consisted of three farmers from across the region sharing their experiences with incorporating cover crops into their operations. Participants also attended a field day that showcased cover crop field demonstrations at the Field Crops Unit of the E.V. Smith Research Center in Shorter, AL. ARS Ag. Engineer, Ted Kornecki also of the NSDL, presented information about and demonstrated conservation tillage equipment he developed for small-scale producers during a field demonstration.

August 1, 2019, Dr. Kip Balkcom remotely attended a data review and planning meeting for the feedstock development team of the Southeast Partnership for Advanced Renewables from Carinata (SPARC) in Quincy, FL with 40 total attendees. Dr. Balkcom is conducting a study to examine interactions between tillage systems and seeding rates for carinata, so he provided an update to the group about this research and interacted with the other participants regarding their research areas related to the overall project.

August 23, 2019, Dr. Kip Balkcom was invited to present at an Alabama Agricultural Experiment Station sponsored field day about soil compaction differences following winter stocker grazing as part of determining how grazing cover crops affects soil health. The Field Crops Day was held in Headland, AL with approximately 100 attendees.

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