National Soil Dynamics Laboratory

Highlights

Spring 2021

United States Department of Agriculture

Agricultural Research Service

Small and Urban Conservation Farming Equipment

The number of local small farms in the US is on the rise due to a consumer demand for locally grown vegetable crops. Recent efforts at NSDL have encouraged producers to adopt conservation agriculture techniques using cover crops. However, lack of specialized equipment inhibits widespread adoption of these systems for small farm producers.

A suite of small farm equipment was developed to enable use of conservation systems at the small farm (garden size) level. A powered coulter no-till seed drill (Fig. 1), powered roller/crimper (Fig. 2), and no-till transplanter (Fig. 3)

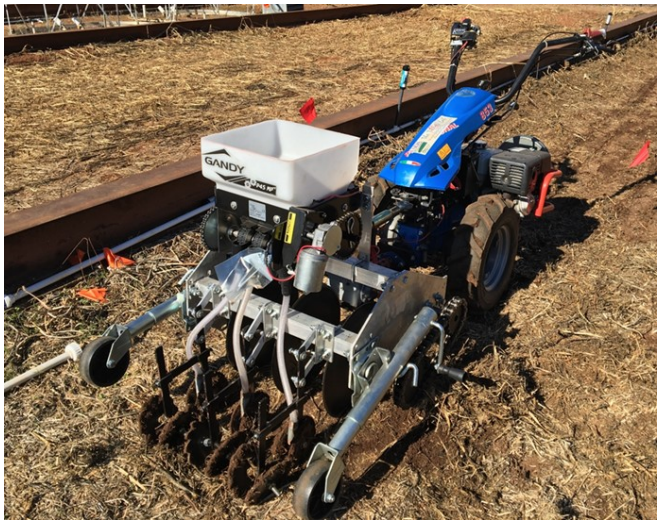

Figure 1. Powered coulter no-till seed drill (working width: 24", spacing between coulters 8", weight: 264 lb) for a BCS 853 Tractor; US patent application #14501594.

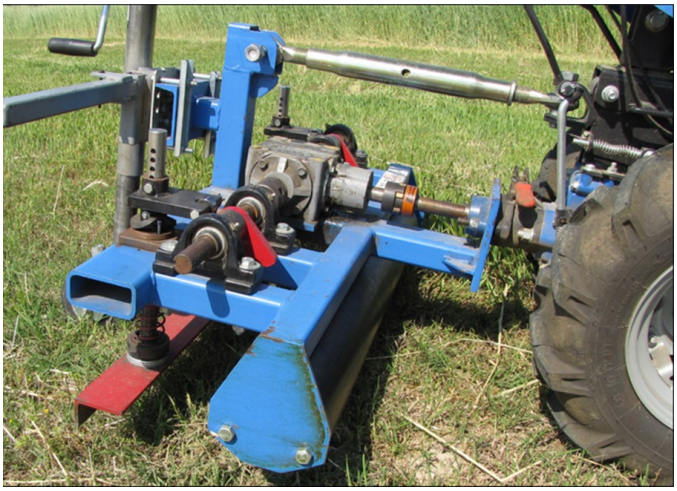

Figure 2. Powered roller/crimper with crimping bar (red color) weighing 190 lb, preloaded with two compression springs: US patent # 7,987,917 B1.

Dynamically Speaking

H. Allen Torbert
Research Leader

The National Soil Dynamics Laboratory (NSDL) is continuing to work under "maximum teleworking" status due to the COVID-19 outbreak, but we are also still all healthy and managing to get research accomplished. We are all looking forward to getting out of our home offices and getting to the field to manage experiments for this Spring. I would like to announce that the US Congress 2021 budget substantially increased our base funding for the NSDL to support our research to increase the environmental sustainability of pasture and forage-based beef production systems in Alabama. We are looking forward to working with Auburn University's Animal Science Department with this research. 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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... Farming Equipment cont.

Figure 3. No-till transplanter weighing 275 lb for walk behind tractor: US patent # 10,004,174 B2.

have been developed, tested, and patented for walk-behind tractors.

Results from a 3-year replicated field test (2017 - 2019) conducted at the NSDL soil bins on a sandy loam and clay soil showed that the powered coulter no-till seed drill generated effective rye seed emergence (83%) and produced an average of ~8900 lb/ac of biomass. The experimental powered roller/crimper achieved a 95% rye termination rate three weeks after rolling, and the no-till transplanter resulted in < 10% variation of tomato plant spacing uniformity within the row. These results indicate that small farm equipment can perform successfully in small conservation agriculture farming operations with cover crops, which will allow further adoption of conservation agriculture systems across the US and globe.

Water and Poultry Litter Nutrient Movement through the Soil Profile

Poultry production generates a large amount of poultry litter (PL), which is a mixture of poultry manure and a bedding material, such as pine shavings. When litter is removed from poultry houses, it is typically land-applied on pastures and row crops. Generally, we know little about where nutrients and minerals from litter go once they pass down through the soil surface. Pores in the soil act as pathways for water to carry litter nutrients and minerals down into the soil profile.

To better understand water and nutrient movement, NSDL researchers and researchers in the Auburn University Department of Biosystems Engineering collected cylindrical soil cores from the fine sandy loam soil of a pasture field at the Alabama Agricultural Experiment Station's Sand Mountain Research and Extension Center in Crossville, Alabama.

We used a custom-built hydraulic cylinder apparatus mounted to the front of a tractor (Fig. 4). Using the apparatus, each soil core was extracted by pushing a 6-inch diameter PVC pipe 20 inches into the soil and then lifting the pipe and soil core contained within the pipe, out of the ground. A medical computed tomography (CT) scanner, made available by the Bailey Small Animal Teaching Hospital at the Auburn University College of Veterinary Medicine, scanned each soil core. The scanner produces a 3-D computer representation of each soil core (multiple 0.025" thick slices), including the sizes and locations of soil pores, and connectivity of the pores.

We are using these soil pore results in HYDRUS which is modeling software used for analysis of water flow and solute transport in soil. After the soil cores have been scanned, we are using the cores in the laboratory, where PL will be applied to the top surface of half of the cores. Water will be sprayed on the upper surface of each core to simulate rainfall. Measurement of the quantity and nutrient components of water flow down through each core will be made. These results will be compared with the HYDRUS computer modeling results. We expect the results to be useful in analyzing the movement of water, nutrients, and other solutes through the soil profile.

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Upcoming Events 2021

Dates	Meeting	Location
June 16-18, 2021	Soil and Water Conservation Society (SWCS)- AL Chapter Annual Meeting	Opelika, AL
July 13-15	American Peanut Research and Education Society (APRES) Annual Meeting	Dallas, TX
July 15-17	Southern Peanut Growers Conference	Panama City Beach, FL
July 26-28	SWCS International Annual Conference	Virtual

... Water and Poultry cont.

Figure 4. Jasmeet Lamba, Associate Professor in Auburn University's Department of Biosystems Engineering, working with NSDL researchers to extract soil cores at the Sand Mountain Research and Extension Center at Crossville, Alabama.

Soybean Cultivar Response to Elevated Atmospheric CO_2 Conditions

Atmospheric CO2 has increased from~280 ppm to~410 ppm between pre-industrial times and the present; if current trends in emissions continue, atmospheric CO2 could reach 600 ppm by 2050. Soybean [Glycine max (L.) Merr.] is the fourth most important crop globally in terms of seed production (i.e., 353 million tons produced in 2017) and is an important source of protein for human and livestock consumption. The rise in atmospheric CO2 is known to increase photosynthesis, water use efficiency (WUE), and yield in numerous crops including soybean. In addition, soybean responses to future CO2 levels could partially offset other negative aspects of global change, such as drought or high temperature. Therefore, this important potential benefit should be investigated to identify genotypes with better response to elevated CO2 and the mechanisms contributing to this responsiveness. However, breeding for high WUE could change carbon uptake by leaves and/or seed nutrient levels under high CO2 due to lower stomatal conductance.

In collaboration with Auburn University's Department of Crop, Soil and Environmental Sciences, we conducted a study to evaluate soybean cultivar response to atmospheric CO2 conditions using open top field exposure chambers (OTCs) at the NSDL soil bin facilities. Two cultivars with contrasting WUE were grown under ambient (410 ppm) or elevated (610 ppm) atmospheric CO2 conditions. Seeds were inoculated with a commercial rhizobium to ensure nodulation and plants were grown in 20-liter containers filled with commercial growth media. Containers were placed into OTCs immediately after sowing and all containers were connected to a drip irrigation system. A portable gas exchange instrument (Fig. 5 and 6) evaluated plant photosynthetic performance (leaf and canopy levels), seed mineral composition was measured, and yield was determined at harvest.

Results showed that the low WUE cultivar had higher photosynthesis under high CO2 due to higher stomatal conductance, while the high WUE cultivar compensated by producing more leaf area. However, improved photosynthesis did not translate into more biomass or seed yield under high CO2 compared to the high WUE cultivar that had better assimilate partitioning.

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Recent Publications

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

Frigo, C., Magri, E., Barbosa, J., Sarteretto, L., Araujo, E., de Melo, V., Prior, S.A., Motta, A. 2020. Influence of roadways on heavy metal content in soils and yerba mate tissue in southern Brazil. Management of Environmental Quality. 31(6):1477-1495. https://doi.org/10.1108/MEQ-10-2019-0219.

Magri, E., Gugelmin, E., Grabarski, F., Barbosa, J., Auler, A., Wendling, I., Prior, S.A., Valduga, A., Motta, A. 2020. Manganese hyperaccumulation capacity of Ilex paraguariensis A. St. Hil. and occurrence of interveinal chlorosis induced by transient toxicity. Ecotoxicology and Environmental Safety. 203:111010. http://doi.org/10.1016/j.ecoenv.2020.111010.

Consalter, R., Barbosa, J., Prior, S.A., Vezzani, F., Bassaco, M., Pedreira, G., Motta, A. 2020. Mid-rotation fertilization and liming effects on nutrient dynamics of Pinus taeda L. in subtropical Brazil. European Journal of Forest Research. 140:19-35. https://doi.org/10.1007/s10342-020-01305-4.

Prior, E.M., O'Donnell, F.C., Brodbeck, C., Donald, W.N., Runion, G.B., Shepherd, S.L. 2020. Measuring high levels of total suspended solids and turbidity using small unoccupied aerial systems (sUAS) multispectral imagery. Drones. 4(54). https://doi.org/10.3390/drones4030054.

Xu, R., Tian, H., Pan, S., Prior, S.A., Feng, Y., Dangal, S. 2020. Global N2O emissions from cropland driven by environmental factors and nitrogen addition: comparison and uncertainty analysis. Global Biogeochemical Cycles. 34:e2020GB006698. https://doi.org/10.1029/2020GB006698.

... Greenhouse Gas cont.

Figure 5. Crop, Soil and Environmental Sciences graduate student David Soba using a photosynthesis instrument to measure soybean cultivars in an open top field chamber.

Figure 6. A close-up of the gas exchange measurement chamber (LI-6400 Portable Photosynthesis System).

The high WUE cultivar generally had lower seed mineral concentrations but higher total nutrient amounts due to increased seed yield under high CO_2 vs the low WUE cultivar. Findings showed important genetic variation in soybean response to elevated atmospheric CO_2 that need to be considered in breeding for future CO_2 scenarios.

Happenings

Dr. Andrew Price led a guest seminar in a three day Alabama Cooperative Extension sponsored Certified Crop Advisor training hosted virtually on zoom. The title of his 55 minute presentation was 'Cover Crops and Herbicide Resistant Weed Management'. Class consisted of 60 university extension, private practitioners, and NRCS professionals in total. 12/16/2020

Dr. Kip Balkcom was invited to present at the Virtual Alabama Certified Crop Advisor Training. The title of his presentation was Nitrogen Management in Cover Crop Systems. There were 40 participants that attended the training designated for Soil and Water Management. 12/16/2020

Dr. Kip Balkcom was invited to present at the Virtual 2021 Cotton and Rice Conference. The title of his presentation was Cover Crop Management in the Southeast for Cotton Production Systems. The webinar was prerecorded and made available to participants of the conference at a later date. 12/18/2020

Dr. Kip Balkcom was invited to present at the Alabama Extension sponsored 2021 Central 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. 2/17/2021

Dr. Kip Balkcom was invited to present at the 2021 National Cover Crop Summit. The meeting was virtual, and presentations will be available March 17-18, 2021. The title of his presentation was Maximizing the Potential Soil Health Benefits of Cover Crops. The conference is national and available to persons interested in cover crops across the county and possible other countries. 2/25/2021

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

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