USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

National Soil Dynamics Laboratory

Highlights

Fall 2022

No-Till Equipment Development for Small-Scale Conservation Farming Systems

THE CHALLENGE

An interest in utilizing cover crops for small farming systems is on the rise, as benefits that cover crops provide such as reduced runoff and soil erosion, increased infiltration and water holding capacity, increased soil organic carbon, decreased soil compaction, and improved weed control are crucial for sustainable agriculture. However, for no-till farming, specialized equipment is necessary for cover crop management and for planting/transplanting cash crops into terminated cover crop residue that remains on the soil surface. Most small farms already own lightweight two-wheel tractors; however, a lack of specialized no-till equipment hinders adoption of no-till practices. Recent development of no-till equipment by USDA-NSDL generated a lot of interest from the small-scale farming community, with continuous inquiries regarding availability of this specialized no-till equipment.

Figure 1. Two-stage roller/crimper (US patent #7,987,917 B1) for walk-behind tractors, ride-on version to improve operator's work effort and to increase effectiveness of crimping cover crop.

SOLUTION AND FINDINGS

To help small-size farmers adopting conservation systems, a patented two-stage roller crimper with a ride-on option was developed to reduce working effort. The two-stage roller/crimper, shown in Figure 1, is the NSDL concept used by University of Wisconsin, Agricultural Extension Service to provide a small-scale solution for cover crop management. Most traditional attachments compatible with walk behind tractors require the operator to physically walk and maneuver the handlebars in order to operate the machine, which can be physically demanding. However, the ride-on feature of this roller/crimper gives the small-scale farmer greater comfort to operate for longer hours, resulting in increased productivity.

Dynamically Speaking

H. Allen Torbert
Research Leader

Another growing season is ending and the National Soil Dynamics Laboratory continues to process research data collected from across the state. In this letter, I would like to welcome three new scientists to our research team. Dr. Aleksandr Kavetskiy and Dr. Galina Yakubova are nuclear physicist whose research will focus on the development of our soil scanning technology. Dr. Tony Adesemoye is a Plant Pathologist who will focus on environmental sustainability of pasture and forage production systems in Alabama using plant growth promoting rhizobacteria technology. We are excited about these new research programs that we will be initiating. I hope you enjoy reading about some of the research efforts we have included in this issue of the National Soil Dynamics Highlights.

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http://www.ars.usda.gov/sea/nsdl
334-844-4741

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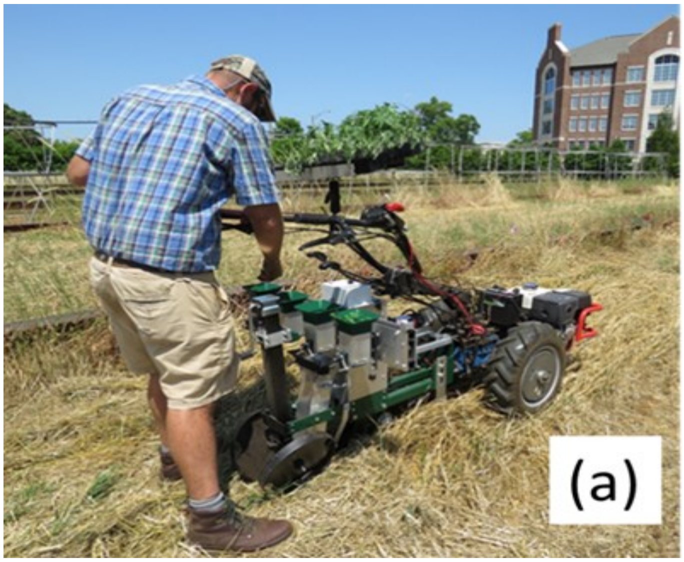

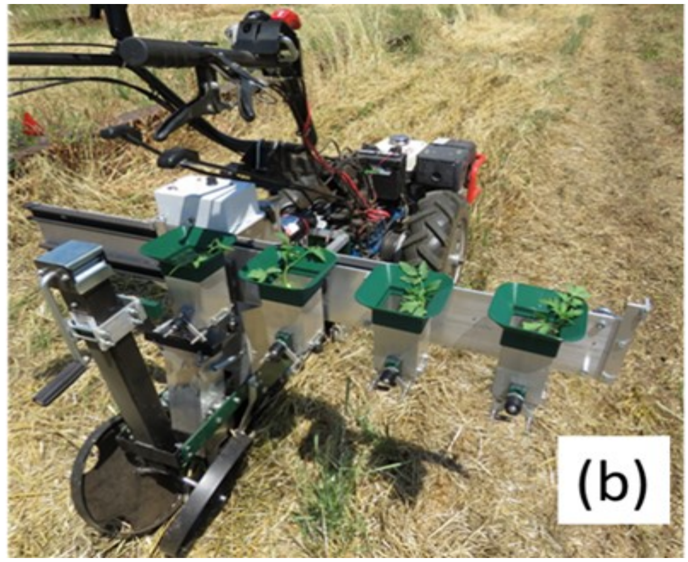

Figure 2. (a) Modified electrically powered no-till transplanter (US patent # 10,004,174 B2). (b) closeup showing holding tubes with tomato seedlings.

Another important no-till attachment that NSDL engineers developed and researched is a patented no-till transplanter for walk behind tractors (Figure 2 (a) and (b)) that was updated to use a 12-volt DC electric motor to better control plant spacing. The original no-till transplanter was powered by PTO and was cumbersome and difficult to change plant spacing for different species and conditions. Testing revealed that improved uniformity in plant spacing was achieved with results showing a coefficient of variation of 6.9% for the improved transplanter version compared to a higher 17.6% for the original transplanter. The developments of the ride-on roller/crimper and no-till transplanter are important in increasing the adoption of conservation agriculture methods on smaller farms around the world.

Integrating Plant Growth Promoting Rhizobacteria into Agricultural Systems

Increasing productivity of agricultural soils is important to a sustainable supply of food, feed, fuel, and fiber for future generations. This demand for increased productivity has resulted in the search for novel strategies to increase crop yield. Agricultural crop yields have more than tripled from 1950 to the present. These advances can be attributed to agricultural research leading to the advent of new technologies and innovations in animal and crop genetics, use of chemical pesticides, fertilizers, and development of mechanized farm equipment. These successful innovations have enabled increases in agricultural output, while labor and land inputs have declined. However, more is needed to ensure food security for the growing world population. To do

Upcoming Events 2022/2023

Dates	Meeting	Location
Nov. 6-9, 2022	Agronomy, Crop Science, & Soil Science Societies' Annual Meeting	Baltimore, MD
Dec. 13-14, 2022	AL Row Crop Short Course	Auburn, AL
Jan. 5-8, 2023	Southeast Vegetable and Fruit Expo	Savannah, GA
Jan. 10-12, 2023	Beltwide Cotton Conf	New Orleans, LA
Jan. 23-26, 2023	Southern Weed Science Society of America Annual Meeting	Baton Rouge, LA
Jan. 31-Feb. 1, 2023	26th Annual National Conservation Systems Cotton & Rice Conf	Baton Rouge, LA
Feb. 4-6, 2023	Southern Branch-ASA Meeting	Oklahoma City, OK
Feb. 14-15, 2023	2023 Southern Cover Crop Council Conf	Baton Rouge, LA

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... Rhizobacteria cont.

this, research is needed to coax greater production out of existing land. Given that agriculture is unquestionably connected to the environment, future innovations must also be environmentally sustainable.

The soil microbial community has been associated with plants since their earliest evolution, assisting plants with access to nutrients and water, as well as with overcoming stressful conditions and pathogens. Thus, identifying soil microorganisms that beneficially promote plant growth may be worth evaluating as a prospective tool. Plant growth-promoting rhizobacteria (PGPR) (Fig. 3) are free-living microbes on or around plant roots that stimulate growth and enhance root development and architecture. When integrated into a conservation nutrient management system, PGPR represent one potential tool to enhance growth, yield, and fertility status of agriculture production.

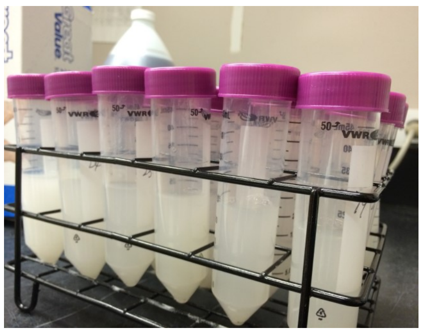

Figure 3. Samples containing plant growth-promoting rhizobacteria (PGPR) in the laboratory.

A large portion of our research at NSDL has focused on evaluating the influence that different mixtures of PGPR have on growth of agricultural crops exposed to different environmental factors under greenhouse conditions (Fig. 4). This research has shown that certain mixtures of PGPR have the potential to increase crop productivity under water stressed conditions and to minimize the need for N fertilizer. This work has also shown that some specifically identified PGPR bacterial inoculants known to promote plant growth can also decrease N_2O emissions regardless of whether a plant is present in soil or not when applied with certain N fertilizers and has led to a Patent (U.S. Patent 9,266,786). Most of these discoveries have been conducted under laboratory and greenhouse conditions. Recently, studies have been initiated in North (silt loam soils) and South-Central Alabama (loamy sand soils) to further evaluate the use of PGPR under field conditions at different fertilizer rates and under irrigated vs. dryland conditions.

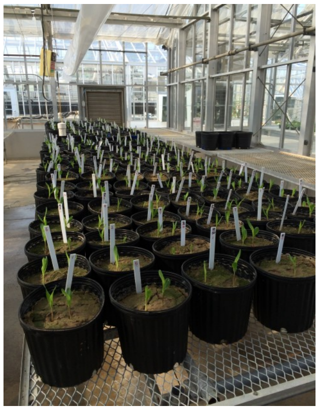

Figure 4. Corn plants growing in different plant growth-promoting rhizobacteria (PGPR) levels in the greenhouse pots.

Recent Publications

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

Balkcom, K.S., Monks, C., Brown, S.M. 2022. Mepiquat chloride applications across two nitrogen rates in a conservation tillage cotton system. Journal of Cotton Science. 26:1-13.

Barbosa, J.Z., Hungria, M., Prior, S.A., Moura, M.C., Poggere, G., Motta, A.C. 2022. Improving yield and health of legume crops via co-inoculation with rhizobia and Trichoderma: A global meta-analysis. Applied Soil Ecology. 176:104493. https://doi.org/10.1016/j.apsoil.2022.104493

Buchaillot, M., Soba, D., Shu, T., Liu, J., Aranjuelo, I., Araus, J.L., Runion, G.B., Prior, S.A., Kefauver, S.C., Sanz-Saez, A. 2022. Estimating peanut and soybean photosynthetic traits using leaf spectral reflectance and advance regression models. Planta. 255:93. https://doi.org/10.1007/s00425-022-03867-6

Budhathoki, S., Lamba, J., Srivastava, P., Malhotra, K., Way, T.R., Katuwal, S. 2022. Characterizing temporal and spatial variability in 3D soil macropore characteristics using x-ray computed tomography. Journal of Soils and Sediments. 22:1263-1277. https://doi.org/10.1007/s11368-022-03150-x

Chakraborty, S., Prasad, R., Watts, D.B., Torbert III, H.A., Kaur, G. 2022. Exploring alternate methods for predicting sorption-desorption parameters for environmental phosphorus loss assessment in poultry litter impacted soils. Journal of Environmental Management. 317(2022):115454. https://doi.org/10.1016/j.jenvman.2022.115454

Korres, N.E., Loka, D.A., Gitsopoulos, T.K., Varanasi, V.K., Chachalis, D., Price, A.J., Slaton, N.A. 2022. Salinity effects on rice, rice weeds, and strategies to secure crop productivity and effective weed control. A review. Agronomy for Sustainable Development. 42:58. https://doi.org/10.1007/s13593-022-00794-4

Li, X., Jiang, J., Guoa, J., Mcclung, A.M., Chen, K., Velarca, M.V., Torbert III, H.A. 2022. Effect of nitrogen application rate under organic and conventional systems on rice (oryza sativa l.) growth, grain yield, soil properties, and greenhouse gas emissions. Journal of Plant Nutrition. https://doi.org/10.1080/01904167.2022.2093746

Wang, J., Watts, D.B., Meng, Q., Ma, F., Zhang, Q., Zhang, P., Way, T.R. 2022. Influence of soil wetting and drying cycles on soil detachment. AgriEngineering. 4:533-543. https://doi.org/10.3390/agriengineering4020036

Zucon, A.S., Pedreira, G.Q., Motta, A.C., Gotz, L.F., Maeda, S., Bassaco, M.V., Magri, E., Prior, S.A., Souza, L., De Oliveira Jr, J.C. 2022. Piling secondary subtropical forest residue: long-term impacts on soil, trees, and weeds. Forests. 13:1183. https://doi.org/10.3390/f13081183

Influence of Biochar Addition to Nursery Container Growth Media

Biochar is a pyrolytic product generated by heating biomass in the absence of oxygen typically performed during processes for bioengery production. Biochar can be made from various feedstocks and research into its potential use in agricultural systems has examined its effects on growth, greenhouse gas emissions (GHG), and nitrogen (N) loss. Ornamental plant producers may be incentivized to change production practices by using products such as biochar to reduce GHG in response to oncoming legislation, potential tax incentives or consumer demand. However, little work has examined biochar use in horticultural container production systems.

Figure 5. Species used in this study: left picture shows viola (Viola cornuta L. 'Sorbet® XP Deep Orange') and right picture shows daylily (Hemerocallis x 'EveryDaylily Cream PBR' L.).

We investigated how biochar additions to growth media affected GHG (CO_2, CH_4, and N_2O), plant growth, and N loss (from leaching) in two separate studies: a peat-based greenhouse study using viola (80:20 peat:perlite amended with 0, 5, 10, 20, or 30% biochar) and a pinebark-based outdoor study using daylily (6:1 pinebark:sand control, or pinebark mixed with 10, 20 or 30% biochar). At the end of the viola study (Fig. 5), there were no differences in top dry weight or total plant N across biochar treatments. Loss of N_2O were lowest for the 30% biochar treatment at one sampling date, but there were no differences in total seasonal losses of CO_2, N_2O or CH_4. In the daylily study (Fig. 5), all biochar treatments generally had lower dry weights (top and roots) and lower total plant N compared to containers with no biochar. Most notably early in the study, the no biochar containers had higher N_2O emissions than any level of added biochar. Total N_2O and CO_2 losses declined with increasing biochar levels suggesting that its use could help mitigate global climate change. Both studies showed that N in leachate was reduced by biochar additions, with higher biochar levels having greater effects on reducing N loss. Reductions in N loss with biochar suggest improved N use efficiencies in ag. systems. Complexities of N management highlight the importance of developing biochar practices that reduce N loss for the benefit of both agriculture and the environment. Future work will focus on evaluating lower biochar rates and differing incorporation strategies on growth and GHG emissions.

Happenings

Dr. Andrew Price presented a field experiment tour for the 2022 Weed Tour hosted by the Auburn University at the Wiregrass Research and Education Center in Headland, AL. Dr Price discussed the management of troublesome weeds in conservation systems. Approximately 70 stakeholders including producers, university extension, industry, and NRCS.

Drs. Kip Balkcom and Andrew Price were invited to present at the Alabama Extension sponsored 2022 Southeast Alabama Cover Crop Field Day. Dr. Balkcom presented information about current and past cover crop research, while Dr. Price discussed weed suppression associated with cover crops. Approximately 40 people attended the field day. Participants were farmers, ag industry personnel, extension specialists, and NRCS personnel.

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