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Growth and Control of Invasive Weeds under Elevated CO₂

NSDL scientists, working on global change effects on weeds, have been invited to present an overview of the effects of elevated atmospheric CO₂ on invasive weeds to the Invasive Plant Working Group at the 2015 American Society for Horticultural Science Annual Meeting to be held in New Orleans, LA.

Atmospheric CO₂ concentrations have been increasing since the onset of the industrial revolution. Regardless of the debate on the effects of this rise on climate, most plants exhibit a positive growth response to elevated CO₂ due to increased photosynthesis, resource use efficiency, and/or allocation to belowground structures. Weeds are no exception. In fact, other ARS researchers have found that the CO₂-induced growth stimulation of several invasive weeds was greater than for any previously examined plant species.

Dynamically Speaking

Spring is in the air and the flowers and trees are starting to bloom. Like farmers throughout Alabama and the Southeast, NSDL staff are traveling across Alabama to establish our experiments. We are busy terminating cover crops, planting cash crops, and everything in between.



H. Allen Torbert
Research Leader

This summer we will welcome Dr. Dara Boardman as a Postdoctoral researcher here at the lab. Dr. Boardman will complete a PhD program at the University of Missouri in Columbia, Missouri in May. She will join the Conservation Systems Research team, where she will join them in their continued research of cover crop management in agricultural systems. We look forward to continuing our ongoing research and starting new research efforts here in Alabama.

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 (<http://www.ars.usda.gov/sea/nsdl>).

We found that several invasive weeds important to the southeastern United States (e.g., Chinese privet, cogongrass, Johnsongrass, purple and yellow nutsedge, ragweed, sicklepod, and spiderwort) are predicted to become more problematic as CO₂ continues to rise. This raises concerns about how weed control strategies in plant production systems will change in a future, higher CO₂ atmosphere. Further complicating this situation is recent evidence suggesting that elevated CO₂ may increase herbicide tolerance in some weeds. This tolerance may be due to a herbicide dilution effect caused by increased growth. Also, changes in weed morphology (e.g., increased leaf thickness) and/or physiology (e.g., decreased stomatal conductance) can alter herbicide uptake, translocation, and overall efficacy. Our early findings suggest that elevated CO₂ will not alter control of purple and yellow nutsedge using current herbicide recommendations (glyphosate and/or halosulfuron).

Weed control strategies will be further complicated by the fact that repeated herbicide applications, particularly those with the same modes of action, results in the development of weed populations resistant to herbicidal control. Herbicide resistant weed populations are continually being identified. To date, approximately 235

Recent Publications

Celik, A., Altikat, S., Way, T.R. 2013. Effects of various strip widths in strip tillage on seed emergence and yield of sunflower. *Soil and Tillage Research*. 131:20-27.

Duzy, L.M., Kornecki, T.S., Balkcom, K.S., Arriaga, F. 2014. Net returns and risk for cover crop use in Alabama tomato production. *Renewable Agriculture and Food Systems*. 29(4):334-344.

Kavetskiy, A., Yakubova, G.N., Torbert III, H.A., Prior, S.A. 2014. Continuous versus pulse neutron induced gamma spectroscopy for soil carbon analysis. *Applied Radiation And Isotopes*. 96:139-147.

Kornecki, T.S., Arriaga, F.J., Price, A.J., Balkcom, K.S. 2013. Effects of recurrent rolling/crimping operations on cover crop termination, soil moisture, and soil strength for conservation organic systems. *Applied Engineering in Agriculture*. 29(6):841-850.

Mourtzinis, S., Arriaga, F., Bransby, D., Balkcom, K.S. 2014. A simplified method for monomeric carbohydrate analysis of corn stover biomass. *Global Change Biology Bioenergy*. 6:300-304. doi:10.1111/gcbb.12140

Runion, G.B., Watts, D.B. 2014. Effects of enhanced efficiency fertilizers on cotton growth characteristics. *Crop Management*. doi:10.2134/cm-2013-0050-RS.

Torino, M., Ortiz, B., Fulton, J., Balkcom, K.S., Wood, C.W. 2014. Evaluation of vegetation indices for early assessment of corn status and yield potential in Southeastern U.S. *Agronomy Journal*. 106:1389-1401.

Watts, D.B., Dick, W.A. 2014. Sustainable uses of FGD gypsum in agricultural systems. *Journal of Environmental Quality*. 43:246-252.

Huyler, A., Chappelka, A.H., Prior, S.A., Somers, G.L. 2014. Influence of aboveground tree biomass, home age, and yard maintenance on soil carbon levels in residential yards. *Urban Ecosystems*. 17:787-805. doi:10.1007/s11252-014-0350-7.

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

Upcoming Events

Dates	Meeting	Location
May 7	Alabama (AL) Invasive Plant Council Annual Meeting (Mtg)	Atmore, AL
June 22-24	Soil and Water Conservation Society (SWCS) - AL Chapter Annual Mtg	Spanish Fort, AL
July 14-16	American Peanut Research and Education Society (APRES)	Charleston, SC
July 23-25	17th Annual Southern Peanut Growers Conf.	Pine Mountain, GA
July 26-29	SWCS Annual Mtg	Greensboro, NC
August 3-5	Nitrogen Use Efficiency Meeting	Auburn, AL
August 10	Climate Adaptation Exchange	Orange Beach, AL
Oct 20-22	Sunbelt Ag Expo	Moultrie, GA

... Growth and Control cont.

different weed species have developed resistance to 22 of the 25 known herbicide modes of action and to 155 different herbicides; herbicide resistant weeds have been reported in 82 crops in 65 countries.

Determining how weed species respond to increased levels of CO₂ and the subsequent effect of increased CO₂ on herbicide efficacy on these weeds is critical to our ability to control important weeds and increase productivity and profitability as atmospheric CO₂ continues to rise. Future work in our group will include examining herbicidal control of other important weeds grown under elevated CO₂. We will also investigate effects of elevated CO₂ on growth and control of weed populations (e.g., amaranth, horsetail, ragweed, etc.) that are either susceptible or resistant to herbicide application.

Conservation Systems for Cotton Production

There are numerous production options available to producers when they are deciding how to manage their crop. Producers are faced with increasing input costs and pressure to produce a crop using environmentally sustainable methods. While many producers have adopted no-till on their operations, it may not be the best production method for all producers depending on soil type. There are other conservation tillage options, such as fall para-till, that producers may consider in place of no-till. Adding a high residue cover crop (Figure 1) into the production system may also provide increased yields, as well as higher net returns.

A field experiment at the Prattville Agricultural Research Unit in Prattville, AL was conducted from fall of 2003



Figure 1. High residue rye cover crop prior to and after rolling.

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... Effect of Conservation cont.

to 2009 on a field that had been in continuous cotton using conventional tillage practices for at least 10 years. Cotton was grown as part of a cotton/corn rotation with each crop present each year. Treatments were four conservation tillage systems (no-till, fall paratill, spring paratill, and spring strip till) and three winter cover crops (cereal rye, winter wheat, and corn residue). The use of spring paratill with a cover crop is shown in Figure 2. Net returns above variable treatment costs were defined as the difference between revenues and cotton production costs (US\$ per lb) associated with each treatment.



Figure 2. Spring paratill in a terminated rye cover crop.

Preliminary results demonstrate that one conservation tillage treatment was not superior across all years for cotton. In five out of six years, yields and net returns above variable treatment costs were either not significantly different or there was not one statistically higher treatment. One exception was in 2006 when the no-till treatment produced higher yields and net returns above variable treatment costs as compared to the remaining treatments. It is important to note that rainfall in 2006 was below the 63-year average rainfall during the growing season. Furthermore, in most years using cover crops produced yields greater than yields following corn residue. In four out of six years, planting cotton after a cover crop produced net returns above variable treatment costs that were either greater than or not different from net returns above variable treatment costs for cotton following corn residue. Conservation tillage with a cover crop in a corn/cotton rotation provides producers with a cotton production system to help reach conservation goals, as well as maintain or exceed yields and net returns above variable treatment costs compared to conservation tillage alone.

Results of this research are found in the article “Conservation Systems to Enhance Soil Carbon Sequestration in the Southeast U.S. Coastal Plain” (K.S. Balkcom, F.J. Arriaga, and E. van Santen. 2013. Soil Sci. Soc. Am. J. 77:1774-1783) and in the proceedings paper “Impact of Conservation Systems on Net Returns to Cotton Production in Alabama” (L.M. Duzy and K.S. Balkcom. 2015. National Cotton Council Beltwide Cotton Conference).

Surface Band Application of Poultry Litter in Row Crops

Production of broiler chickens in the United States is concentrated in the Southeast. Poultry litter is a mixture of poultry manure and a bedding material such as pine shavings, peanut hulls, or rice hulls. Nationwide production of litter from broilers and turkeys is about 14 million tons annually. The conventional method for land application of litter is broadcast application on the soil surface but this method allows nutrients, particularly nitrogen and phosphorus, to be vulnerable to being transported in runoff water, off of fields into streams, rivers, lakes, and other water bodies. Researchers at the NSDL have developed a prototype implement for applying poultry litter in shallow subsurface bands (Figure 1). The implement performs well for litter application in row crops and pastures. The implement functions particularly well in reducing nitrogen and phosphorus nutrients in runoff water following rainfall events, compared to nutrients in runoff water from plots which received conventional surface broadcast application of litter.



Figure 1. Rear view of the prototype implement for subsurface band application of poultry litter. Implement is shown here side-dressing corn.

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... New Methods cont.

An important aspect of fertilizing row crops is the location of the applied fertilizer relative to the seed. A recommended practice for band application of inorganic fertilizer to row crops is to place the band close to the crop row. The prototype implement for subsurface band application of litter can be used for litter application before planting, at planting time, or following crop emergence.

An experiment was conducted by the Waste Management group in the NSDL soil bins to determine corn and cotton crop response, as affected by the location of the subsurface litter band relative to the crop row (Figure 2). One subsurface litter band treatment had the crop row planted directly above the litter band while other treatments placed the litter band 4, 8, or



Figure 2. Cotton (foreground) and corn (background) plots used in the experiment.

12 inches to the side of the crop row. The litter band was approximately 2 inches below the soil surface. A surface broadcast application of litter, using the same litter application rate as was used for the subsurface band application, was also included. Furthermore, a treatment where inorganic liquid fertilizer was injected in a soil slit located 4 inches to the side of the crop row and a treatment with no fertilizer application (control) were included in the experiment. Corn and cotton were harvested to determine the respective yields. All of the subsurface litter application band treatments resulted in satisfactory crop growth and yield compared to the control, the inorganic fertilizer treatment, and the broadcast application treatment. The experiment will be repeated over several years to identify the best placement of the litter band for the corn and cotton.

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Happenings

ARS researchers, Dexter Watts, Stephen Prior, Brett Runion and Allen Torbert, presented research results at the 2015 Southern Branch American Society of America Conference, in Atlanta, GA.

ARS researchers, Ted S. Kornecki and Corey Kichler, attended the annual Alabama Fruit & Vegetable Growers Conference & Tradeshow, Opelika, AL. Dr. Kornecki and Mr. Kichler presented cover crop management in conservation tillage systems at the ARS-NSDL booth where video of terminating cover crops, fact sheets and brochures was presented. This conference, in addition to Alabama producers, was attended by specialists from Auburn University extension, USDA-NRCS and supporting industry.

ARS researchers, Ted Kornecki and Mr. Corey Kichler, attended and presented at the 2015 Southern Sustainable Agriculture Working Group Conference held in Mobile, AL. Dr. Kornecki made a presentation titled "Organic Kale and Cereal Rye Grain Production Following a Sunn Hemp Cover Crop" and Mr. Kichler demonstrated rollers/crimpers for walk behind tractors.

ARS researchers, Kipling S. Balkcom and Leah M. Duzy attended and presented at the 2014 Alabama Corn and Wheat Short Course held in Auburn, AL. Dr. Balkcom made a presentation on nitrogen management for Alabama wheat and Dr. Duzy presented on the environmental and economic benefits of conservation systems in the Southeast.

ARS researchers, Kip Balkcom, Andrew Price, Steve Prior, Allen Torbert, and Dexter Watts, attended the ASA, CSSA, & SSSA International Annual Meeting at Long Beach, CA. Dr. Balkcom was invited to speak at the Cover Crops and Soil Health Symposium and presented the paper "Soil Health Benefits Using Cover Crops across the Southeast". Dr. Torbert was invited to speak at the Science behind a Soil Conservation Practice Standard for Soil Amendments Symposium and presented the paper "Soluble Calcium Amendment: Co-Application with Poultry Litter to Reduce P Loss Following Surface Application". Dr. Price was invited to present the paper "Managing Weeds in Conservation Systems: Overcoming Herbicide-Resistant-Weeds in the Mid-South and Southeastern U.S." Dr. Prior served as chair of the ASA Land Management and Conservation Section.

ARS researcher Ted Kornecki attended the Organic Food Systems for Sustainable Production and Enhanced Ecosystem Services Workshop in Long Beach, CA.

ARS researcher Leah Duzy attended the Beltwide Cotton Conference in San Antonio, TX. She presented the following papers: "Who, What, and Where: Cotton Production in the United States 1997 - 2012" and "Impact of Conservation Systems on Net Returns to Cotton Production in Alabama."

ARS researchers Kip Balkcom and Leah Duzy attended a cover crop training session hosted by NRCS at the NRCS Jimmy Carter Plant Materials Center in Americas, GA.

Send updated contact information, questions, comments, and/or suggestions to: NSDL-Highlights@ars.usda.gov

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