National Soil Dynamics Laboratory

Highlights

United States Department of Agriculture

Agricultural Research Service

Fall 2020

Effects of CO_2 on Herbicidal Control of Pigweed

Plants use carbon dioxide (CO2) to build tissues and the rising level of CO2 in the atmosphere (due largely to human activities) usually leads to larger plants. Plants vary in their growth response to higher levels of CO2 with C4 grass-type plants (like corn and sorghum) showing 10-20% increases in growth and yield and C3 flowering plants (like cotton and soybean) increasing around 30%. Unfortunately, this is true for weeds as well as crop plants. In fact, weeds have been shown to exhibit greater growth increases to elevated atmospheric CO2 than crop plants, prompting speculation that herbicide rates may need to be increased to maintain effective control.

Palmer amaranth (*Amaranthus palmeri* [S.] Wats.), commonly called pigweed, is a problem in many cropping systems in the southeastern US (Figure 1). Some pigweed populations have been found to exhibit resistance to herbicides such as glyphosate. The Global Change group investigated how growth under high CO2 impacted herbicidal control of this problematic pigweed. Seed from both a glyphosate resistant and a glyphosate susceptible population were germinated in a greenhouse and transferred to open top field chambers for exposure to a normal atmospheric CO2 level and an elevated (+ 200 ppm) atmospheric CO2 level. Plants were grown under ambient and elevated CO2 conditions for 16 days prior to being sprayed with glyphosate at ½, 1, and 1½ times the recommended label rate plus an untreated control. Plants were returned to the CO2 chambers and held for 11 days before being destructively harvested.

Unlike previous high CO2 studies, we did not observe an increase in plant dry weight (top, root, or total) due to growth under high CO2. It was our intent to have plants of a size that farmers would encounter in the field requiring herbicidal control. Therefore, the short CO2 exposure period may explain the lack of a growth response to elevated CO2. All rates of glyphosate reduced growth of susceptible plants compared to control under both levels of CO2. However, resistant plants were unaffected by glyphosate, regardless of rate, under both CO2 treatments. Results from this short-term study suggest that weed control strategies for these populations of pigweed (glyphosate resistant and susceptible) should not be altered under future conditions of elevated atmospheric CO2.

Figure 1. Palmer amaranth (pigweed).

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Dynamically Speaking

H. Allen Torbert
Research Leader

I am happy to let you know that everyone at the National Soil Dynamics Laboratory (NSDL) is healthy, but we are still in "maximum telework" status due to the COVID-19 outbreak. This means that we are mostly still working from home.
Nevertheless, we have managed to keep our field projects going so far this year. In addition, we have even been able to move forward with some much needed hiring of new staff. Therefore, in this letter, I would like to welcome Thomas Counts and Jason Amling to our technical support staff. In addition, while not new to NSDL, I would also like to welcome Tammy Dorman to her new role as Administrative Officer for the ARS Auburn Location.
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 website for more information about our ongoing projects.

National Soil Dynamics Laboratory
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Upcoming Events 2020		
Dates	**Meeting**	**Location**
Nov. 9-13, 2020	Agronomy, Crop Science, & Soil Science Societies' Annual Meeting	Virtual
Jan. 5-7, 2021	Southeast Vegetable and Fruit Expo	Virtual
Jan. 5-7, 2021	Beltwide Cotton Conf.	Virtual
Jan. 25-26, 2021	Southern Weed Science Society of America Annual Meeting	Virtual
Jan. 30-Feb. 1, 2021	Southern Branch-ASA Meeting	Virtual
Feb. 4-9, 2021	Southern Association of Agricultural Scientists Annual Meeting	Irving, TX
Feb. 9-11, 2021	24th Annual National Conservation Systems Cotton & Rice Conference	Virtual
March 5, 2021	Georgia Organics Annual Conference	Columbus, GA

Rye Delays Weed Emergence and Reduces Potential Cotton Yield Loss

In the Mid-South and Southeast United States cotton producing states, pigweed, crabgrass, morningglory, nutsedges, goosegrass, and sicklepod are the highest ranked troublesome weeds. Widespread herbicide resistant horseweed and Palmer amaranth in this area has reemphasized the need for integrated herbicide resistant weed control strategies. Our recent pigweed research has focused on integrated cultural and chemical weed management strategies to provide effective control and reduce selection pressure for resistance development.

The critical period for weed control (CPWC) is the time interval in crop growth when a weed-free state must be maintained to prevent substantial (≥5%) yield loss. The CPWC has two separately measured weed-crop competition components: 1) the critical timing for weed removal (CTWR i.e. the maximum time duration the crop can tolerate early-season weed competition before incurring increasingly substantial yield loss) and 2) the critical weed-free period (CWFP; i.e. the minimum time duration from time of planting onward when a crop needs to be kept weed free to prevent substantial yield losses above a predetermined level). The CTWR determines the beginning of CPWC while CWFP determines its end; the combination of both components determines the duration of CWFP. Weeds that are present before or emerge after this period do not cause significant (>5%) yield loss.

We hypothesized the use of cover crops managed for maximum biomass could decrease or delay weed emergence, effectively reducing the CPWC. A field experiment was conducted to evaluate the CPWC in cotton as affected by a high biomass cereal rye cover crop and tillage. The three management systems evaluated included conventional tillage following winter fallow, conservation tillage (CT) following winter fallow, and CT following a cereal rye cover crop (Fig. 2) managed for maximum biomass. Throughout most of the growing season, weed biomass in cereal rye cover crop plots was less than the CT winter fallow system in both years, and less than both CT winter fallow and conventional tillage in one year. The presence of a rye cover crop delayed the CTWR approximately 8 days compared to the fallow treatment both years, while conventional tillage delayed CTWR about two weeks compared to winter fallow. Relative yield losses in both years did not reach the 5% threshold limit until about 2 weeks after planting (WAP) for CT following winter fallow, 3 WAP with CT following a rye cover crop, and 3.5 WAP following conventional tillage. Thus, CT following winter fallow should be avoided to minimize cotton yield loss.

Figure 2. Cotton grown in a conservation tillage and cereal rye production system.

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Figure 3. Leaching of horticulture nursery containers.

Reducing P Leaching from Containerized Media with Gypsum

Phosphorus (P) loss from agricultural production systems is the major culprit causing blooms of harmful algae to occur in rivers, lakes and streams. Once excess algae growth ensues in these fresh water ecosystems, the water becomes depleted of oxygen causing dead zones to occur that damages the vitality of these systems for aquatic life. Scientist at the NSDL have been researching ways to improve water quality by binding P into the soil under forage and row crop production systems to prevent it from running off. Research discoveries from this lab have shown that flue gas desulfurization (FGD) gypsum can be used as a soil additive to curb P losses from these agricultural fields. This FGD gypsum source is produced as a byproduct of removing sulfur from emissions at coal-fired electric utility plants. Thus, there is no shortage of this synthetic gypsum source; half of this material has to be landfilled.

Similar to forage and row crop production systems, horticultural nursery production can be responsible for introducing P into the environment. Throughout the US, nursery crops are primarily being grown in containerized production using light-weight soil-less media, primarily consisting of pine bark or peat-based substrates. This media has a high percentage of air space for enabling the growth of plants in containers. However, as a result of this

Recent Publications

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Lin, Y., Watts, D.B., Kloepper, J.W., Adesemoye, A.O., Feng, Y. 2019. Effect of plant growth promoting rhizobacteria at various nitrogen rates on corn growth. Agricultural Sciences. 10:1542-1565. https://doi.org/10.4236/as.2019.1012114.

Watts, D.B., Runion, G.B., Purswell, J.L., Torbert III, H.A., Davis, J.D. 2019. FGD gypsum litter effects on gaseous losses from a broiler house. International Journal of Poultry Science. 19:42-50. https://doi.org/10.3923/ijps.2020.42.50.

Kornecki, T.S. 2020. Impact of different cover crops and termination methods on collard yield. European Agrophysical Journal. Vol 6, No 4: 50-66.

Balkcom, K.S., Bowen, K.L. 2020. Corn response across plant densities and row configurations for different moisture environments. International Journal of Agronomy. vol. 2020. Article ID 4518062, 10 pages, https://doi.org/10.1155/2020/4518062.

Jani, A.D., Mulvaney, M.J., Balkcom, K.S., Wood, C., Jordan, D.L., Wood, B.H., Devkota, P. 2019. Peanut residues supply minimal plant-available nitrogen on a major soil series in the USA peanut basin. Soil Use and Management. 36:274-284. https://doi.org/10.1111/sum.12563.

Lin, Y., Watts, D.B., Torbert III, H.A., Howe, J.A., Feng, Y. 2020. Integration of poultry litter and mineral N on growth and yield of winter canola. Agronomy Journal. 112:2496–2505. https://doi.org/10.1002/agj2.20158.

Tekeste, M., Way, T.R., Syed, Z., Schafer, R. 2020. Modeling soil-to-bulldozer blade interaction using the discrete element method (DEM). Terramechanics Journal. 88:41-52. https://doi.org/10.1016/j.jterra.2019.12.003.

Lin, Y., Watts, D.B., Torbert III, H.A., Howe, J.A. 2020. Influence of nitrogen rate on winter canola production in the Southeastern US. Agronomy Journal. 112: 2978–2987. https://doi.org/10.1002/agj2.20197.

Barbosa, J.Z., Pereira, G.Q., Motta, A., Poggere, G.C., Prior, S.A., Goularte, G.D. 2020. Global trends in apps for agriculture. Multi-Science Journal. 3(1):16-20. https://doi.org/10.33837/msj.v3i1.1095.

Ferreira, C., Bassaco, M., Araujo, E., Pauletti, E., Prior, S.A., Motta, A. 2020. Gypsum effects on eucalyptus nutrition in subtropical Brazil. Brazilian Journal of Development. 6(5):25160-25177. https://doi.org/10.34117/bjdv6n5.

Motta, A., Araujo, E.M., Broadley, M.R., Young, S.D., Barbosa, J.Z., Prior, S.A., Schmidt, P. 2020. Minerals and potentially toxic elements in corn silage from tropical and subtropical Brazil. Revista Brasileira de Zootecnia. 49:e20190214. https://doi.org/10.37496/rbz4920190214.

Soba, D., Shu, T., Runion, G.B., Prior, S.A., Fritschi, F., Aranjuelo, I., Sanz-Saez, A. 2020. Effects of elevated [CO2] on photosynthesis and seed yield parameters in two soybean genotypes with contrasting water use efficiency. Environmental and Experimental Botany. 178:104154. https://doi.org/10.1016/j.envexpbot.2020.104154.

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... Reducing Leaching cont.

Figure 4. Applying water to horticulture nursery containers.

Figure 5. Differences in leachate clarity between 15% FGD gypsum + media and the 100% media.

Happenings

Dr. Andrew Price guest lectured twice in Auburn University Entomology and Plant Pathology 'Integrated Pest Management' class. The title of his presentation was 'Cover Crops As An Aid In Weed Management'. 4/7/2020

Mr. Aleksandr Kavetskiy and Drs. Galina Yakubova,, Steve Prior, and Allen Torbert presented at the International Conference on Agricultural Soil Science and Soil Analysis (ICASSSA 2020) in San Francisco, CA. The title of the presentation was 'Neutron-gamma technology for soil elemental analysis and mapping'. 6/4-5/2020

Dr. Kip Balkcom was invited to present at an Alabama Agricultural Experiment Station sponsored virtual field day about cover crop mixtures preceding corn. Dr. Balkcom's presentation was recorded and posted to an Alabama Agricultural Experiment Station FaceBook page. 8/21/2020

Dr. Kip Balkcom was invited to present at the Virtual Cover Crop In Service Training for Alabama, Georgia, and Florida. The title of his presentation was 'Nitrogen Management and Cover Crops'. 9/21/2020

high porosity, frequent daily irrigation cycles are required (upwards of 1/2 acre inch of water or more). In addition, the media components have a low nutrient sorption capacity often allowing as much as 75 % of the applied P to be lost from the containers. One approach to reduce horticulture's footprint on the environment could be to amend the nursey containers with FGD gypsum. A series of pilot studies were conducted by NSDL scientist to evaluate varying rates of FGD gypsum in pine bark substrates and its effectiveness on P retention within the media. These horticultural leaching experiments consisted of evaluating two fertilizer sources (fast release and slow release), four gypsum rates (2.5, 5, 10, and 15% v/v gypsum:media), and two application methods (mixed or placed at base of container). The containers were saturated and leached daily (Figs. 3 and 4). Preliminary evaluations showed that the FGD gypsum was effective at retaining P within the container (Fig. 5). Dissolved P concentrations in leachate decreased over time regardless of whether the containers were fertilized with a slow release or fast release fertilizer. With both FGD gypsum application methods, increasing FGD rates decreased dissolved P that leached. Mixing FGD gypsum with the media tended to be more effective than placing the gypsum at the base of the media containing the fast release fertilizer, while the two FGD gypsum application methods were comparable for media containing the slow release fertilizer. Initial results from these experiments suggest that the addition of FGD gypsum to containerized nursey media could be a new management strategy for improving the sustainability of our environment.

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