

## Michigan- MCCC State Report 2014

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### **Effect of Cover Crops On Nitrous Oxide Emissions, Nitrogen Availability and Carbon Accumulation in Organic Versus Conventionally Managed Systems:** Dean Baas

([baasdean@msu.edu](mailto:baasdean@msu.edu)), Neville Millar ([millarn@msu.edu](mailto:millarn@msu.edu)), Phil Robertson ([robertson@kbs.msu.edu](mailto:robertson@kbs.msu.edu)) and Victoria Ackroyd ([ackroydv@msu.edu](mailto:ackroydv@msu.edu)) This research investigates the effects of various cover crops, specifically their residue quality and termination time, on nitrous oxide (N<sub>2</sub>O) emissions, nitrogen (N) availability patterns and carbon (C) accumulation in major Midwest field crop systems under organic and conventional management. Our goals are 1) to determine the potential of cover crops as management options for improving N synchrony with cash crops, 2) evaluate the impact of cover crops on N<sub>2</sub>O emissions, and 3) improve farmer knowledge of cover crop utilization in relation to N utilization. After three years of our experiment, we have data on how much nitrous oxide is emitted from soils that are planted to corn, soybeans and wheat, both with and without cover crops and managed conventionally or organically. Over these three years the average total emissions of nitrous oxide from organically managed crops were about five times higher than emissions from conventionally managed crops. This was due to short-lived, but very high releases of nitrous oxide that followed the addition to the soil of poultry manure and cover crop residues. Adding these large amounts of carbon and nitrogen to the soil, in combination with heavy rains and soil disturbances for organic weed control, likely caused these very high emissions. Planting winter cover crops had no affect on nitrous oxide emissions when compared to situations where cover crops were not planted. This was true in both management systems. This is good news for farmers who want to include cover crops in their crop rotations – they can profit from the benefits of using cover crops while not increasing nitrous oxide emissions from their soils in the process. The time at which the cover crops were killed and added to the soil also did not make a difference to nitrous oxide emissions. This is also beneficial to farmers, who can choose the time to kill their cover crops that best suits their conditions, again knowing that this timing does not affect nitrous oxide emissions from their soils. This project is funded through a USDA NIFA Organic Transition Grant.

### **Presentations:**

Millar N, DG Baas, SR Miller, DR Mutch and GP Robertson (2014). Nitrous oxide emissions from Cover Crop systems: Comparisons within and between Conventional and Organic management systems. Electronic conference proceedings (abstract). ASA–CSSA–SSSA International Annual Meeting, Long Beach, CA. November 2014.

Millar N and GP Robertson (2014). Manual Chamber Sampling Strategies to Help Account for Temporal Variability of Nitrous Oxide Emissions from Agricultural Cropping Systems. in Measuring Nitrous Oxide Emissions from Soil Workshop. Electronic conference proceedings (abstract). ASA–CSSA–SSSA International Annual Meeting, Long Beach, CA. November 2014.

Millar N, DG Baas, SR Miller, DR Mutch and GP Robertson (2014). Nitrous Oxide Emissions from Row-Crop Systems: Comparing Presence and Absence of Winter Cover Crops. Great Lakes Bioenergy Research Center (GLBRC). Annual Retreat, South Bend, IN. May 2014. (Poster Presentation)

**Using cover crops with wheat to improve rotational profitability.** Dean Baas ([baasdean@anr.msu.edu](mailto:baasdean@anr.msu.edu)) and Paul Gross ([grossp@anr.msu.edu](mailto:grossp@anr.msu.edu)). Historically, crop rotations have been much more diverse than they are at the present time. The lack of more sophisticated crop rotations has resulted in crop yield reductions, increased pest problems and poor soil quality. This proposal will evaluate corn only, soybean only, corn/soybean and corn/soybean/wheat with and without cover crops at two locations. These plots will be evaluated for the economic and agronomic performance of rotations with wheat only added and wheat with and without three cover crops over three years. We believe incorporating wheat into the soybean rotation will enhance soybean yields, decrease incidence of soybean cyst nematodes/sudden death syndrome and increase profits for soybean growers in Michigan. This project is funded equally

through the Michigan Soybean Promotion Committee, the Michigan Wheat Program and the Corn Marketing Program of Michigan.

#### **Field Day:**

The Michigan State University Saginaw Valley Research and Extension Center (Frankenmuth, MI) research site was toured by 180 farmers during the 2014 Wheat Field Day.

**Evaluation of Oilseed Radish Added to wheat to Increase Wheat Yields in Michigan.** Dean Baas ([baasdean@anr.msu.edu](mailto:baasdean@anr.msu.edu)). This project is continuing to investigate the reported yield increase that comes from interseeding oilseed radish in wheat. Trials are conducted on four farms and the W.K. Kellogg Biological Station (KBS) in 2013/2014 at an oilseed Radish seeding rate of 3 lbs/acre. On one farm, 1.5 and 4.5 lbs/acre seeding rate was being tested. At KBS, all three seeding rates and three planting dates were evaluated. Results were mixed this year for the impact of oilseed radish interseeded with wheat on wheat yield most likely due to late planting and the harsh winter. We are continuing to be analyze the 2013/2014 results. Trials are continuing for the 2014/2015 growing season. This project was funded by the Michigan Wheat Program.

**Cover Crop Mixes and Greenhouse Gas Studies:** Victoria Ackroyd ([ackroydv@msu.edu](mailto:ackroydv@msu.edu)), Christy Sprague ([sprague1@msu.edu](mailto:sprague1@msu.edu)) and Dean Baas ([baasdean@msu.edu](mailto:baasdean@msu.edu)). An extensive cover crop mixes experiment looking at a variety of grasses and legumes, and two-species mixes of a grass or legume + oilseed radish was completed this year. The amount of nitrogen lost to greenhouse gas emissions in fall-planted cover crop systems was included for oilseed radish, annual ryegrass and a mixture of the two species. Data from these experiments are being analyzed by Ph.D. candidate Victoria Ackroyd. Three different cover crops project dissertation chapters/journal articles are in the works. The first concerns a brassica cover crop variety trial conducted by Michigan State University Extension and the USDA-NRCS Rose Lake Plant Materials Center. The second focuses on the performance of simple cover crop mixtures wherein radish was the common-denominator species, and followed through to the impact of the cover crops on a following corn cash crop. The third investigated fall-summer nitrous oxide emissions in oilseed radish, annual ryegrass, and oilseed radish + annual ryegrass treatments.

#### **Presentation:**

Ackroyd, V., D. Mutch, D. Baas, and C. Sprague. 2013. Impact of Fall-Planted Cover Crops on Greenhouse Gas Emissions and Corn Growth and Yield. Electronic conference proceedings (abstract). ASA-CSSA-SSSA International Annual Meeting, Long Beach, CA. November 2014.

**Cover Crop Educational Outreach 2014:** Christina Curell ([curellc@anr.msu.edu](mailto:curellc@anr.msu.edu)) and Paul Gross ([grossp@anr.msu.edu](mailto:grossp@anr.msu.edu)). Michigan State University Extension educators held cover crop presentations and field demonstrations across Michigan. Commodity groups represented included field crops, vegetables, Christmas trees, horticulture crops, tree and small fruit, and livestock groups. Incorporating cover crops in grazing systems is being used to extend the season and improve soil health in pastures. A new and growing audience for cover crop education is urban farmers. On-farm field demonstrations highlighted cover crop species, cocktail mixes, and various seeding methods. These practices were part of summer and fall farm tours. The cover crop team in partnership with the University of Wisconsin Extension held a two day field day/training for agronomist for DuPont Pioneer Seed Company. Educators discussed and demonstrated how cover crops can build soil and help increase productivity. Soil pits were used to demonstrate root types and rooting depth of various cover crop species. This past year a group of Michigan Extension Educators and Specialists pooled resources to purchase a rainfall simulator. This simulator is used to demonstrate the effects of precipitation on farm fields. The simulator allows side by side comparisons of different farming practices. In every instance cover crops are used to show how they can reduce soil erosion.

### **Field Days/Presentations:**

Over 50 cover crop related fields and presentations were held by Michigan State University Extension educators. The rainfall simulator was used at 24 different field days.

**Integrating reduced tillage and flowering windbreaks for insect and weed management in cucurbits.** Zsafia Szendrei ([szendrei@msu.edu](mailto:szendrei@msu.edu)) and Dan Brainard ([bainar9@msu.edu](mailto:bainar9@msu.edu)). We are beginning several studies evaluating the i) effects flowering cover crops including yellow mustard, sweet allysum, crimson clover, and buckwheat on pollinators and beneficial insects in cucumbers; ii) the impact of rye surface residue in combination with strip tillage on weeds and insects in winter squash. Funding Source: NC-IPM Program.

**Combining strip-tillage and cover crops for resource conservation and profit in north central vegetable cropping systems.** Zsafia Szendrei ([szendrei@msu.edu](mailto:szendrei@msu.edu)), Dan Brainard ([bainar9@msu.edu](mailto:bainar9@msu.edu)) and Ron Goldy ([goldy@msu.edu](mailto:goldy@msu.edu)). We are entering the seventh year of a long-term study evaluating the impact of cover crops (none, rye or rye-vetch) and tillage (conventional or strip till) on weeds, insects, soil moisture conservation and profitability in a sweet corn – snap beans – winter squash rotation. A report through the 2014 field season can be found at: <http://mysare.sare.org/mySARE/ProjectReport.aspx?do=viewProj&pn=LNC11-330>. Funding Source: NC-SARE Program.

**Zonal cover-cropping and tillage for weed and nutrient management in organic sweet corn.** Carolyn Lowry ([lowrycar@msu.edu](mailto:lowrycar@msu.edu)) and Dan Brainard ([brainar9@msu.edu](mailto:brainar9@msu.edu)). We are investigating whether alternating rows of rye and vetch can provide benefits relative to standard full-width mixtures. In the alternating row system, hairy vetch is planted directly in-line with future sweet corn rows (IR) and rye is planted between crop rows (BR). We hypothesize that this system will improve N use efficiency, improve weed suppression, lower seed costs, and—when combined with strip tillage—reduce the risk of vetch regrowth. A report on findings from the 2014 season can be found at: <http://mysare.sare.org/MySare/ProjectReport.aspx?do=viewRept&pn=GNC10-141&y=2013&t=1>. Funding Sources: NC-SARE; CERES Trust.

**Cover crops for nitrogen, nematode and weed management in processing carrots.** Dan Brainard ([brainar9@msu.edu](mailto:brainar9@msu.edu)), Dean Baas ([baasdean@msu.edu](mailto:baasdean@msu.edu)), Haddish Melakeberhan ([melakebe@msu.edu](mailto:melakebe@msu.edu)), Ben Werling ([werlingb@msu.edu](mailto:werlingb@msu.edu)). We are investigating the impact of cover crops sown in late summer following early harvested vegetables or wheat on weeds, nitrogen, and nematodes in a subsequent carrot crop. Seven cover crop treatments (none, oats, cowpea, oilseed radish, Dwarf Essex Rape, oats-cowpea, oats-oilseed radish) were sown in two separate on-farm trials in 2014. Soil N dynamics, weeds, nematodes and carrot quality and yield will be evaluated in 2015. Funding Sources: Project GREEN, Michigan Vegetable Council, Michigan Carrot Council.

**Farmer-Designed Systems to Reduce Tillage in Organic Vegetables.** Dan Brainard ([bainar9@msu.edu](mailto:bainar9@msu.edu)), Zsafia Szendrei ([szendrei@msu.edu](mailto:szendrei@msu.edu)), Vicki Morrone ([sorrone@msu.edu](mailto:sorrone@msu.edu)), with collaborators from Cornell University and University of Maine. As part of a larger project, we are evaluating cover crop combinations and spatial arrangements which will enhance ecosystem services and profitability in reduced tillage systems (strip till and permanent beds) for organic vegetable producers. This is the first year of a four year grant. Funding Sources: USDA-OREI.

**Reclaiming soil health and the natural productivity of crop land.** Tim Harrigan ([harriga1@anr.msu.edu](mailto:harriga1@anr.msu.edu)), Dean Baas ([baasdean@anr.msu.edu](mailto:baasdean@anr.msu.edu)), Marilyn Thelen ([thelen22@anr.msu.edu](mailto:thelen22@anr.msu.edu)), Christina Curell ([curellc@anr.msu.edu](mailto:curellc@anr.msu.edu)) and Paul Gross ([grossp@anr.msu.edu](mailto:grossp@anr.msu.edu)). This is a CIG project with three farmer cooperators in geographically diverse areas of Michigan on coarse, irrigated ground; a medium loam and a fine-textured tile-drained ground. We have paired strip trials with a typical farming

practice for the farm and one or two challenger systems designed to ramp up the rate of soil health improvement using cover crops, low intensity tillage and manure at each site. Funding source: NRCS Conservation Innovation Grant.

**Vertical tillage for managing high-yielding corn residue and cover crop establishment.** Tim Harrigan ([harriga1@anr.msu.edu](mailto:harriga1@anr.msu.edu)) and Marilyn Thelen ([thelen22@anr.msu.edu](mailto:thelen22@anr.msu.edu)). We are evaluating a range of vertical tillage tools for managing high-yielding corn residue and rapid incorporation of cover crop seed following corn and before soybeans. Funding sources: Corn Marketing Program of Michigan and Michigan Soybean Promotion Committee.

**Cover crop and herbicide interactions: A Michigan perspective.** Erin Hill ([hiller12@msu.edu](mailto:hiller12@msu.edu)), Christy Sprague ([sprague1@msu.edu](mailto:sprague1@msu.edu)) and Karen Renner ([renner@msu.edu](mailto:renner@msu.edu)). Michigan is ranked fifth in the nation in terms of cover crop acreage; with over 400,000 cover crop acres representing nearly 6% of the total cropland in the state. As cover crop use has increased so have grower questions to Michigan State University Extension. Top concerns in Michigan include: carryover issues with herbicides used prior to cover crop establishment, cover crop termination with herbicides, and the potential for cover crops to become weeds. Ongoing field and greenhouse experiments examine the influence of residual corn and soybean herbicides on the establishment and growth of cereal rye, oilseed radish, and medium red clover, and the impact of postemergence wheat herbicides on established medium red clover. Early results indicated that cereal rye, currently the most widely used cover crop in Michigan, is the least susceptible of these three cover crops to residual corn and soybean herbicides. Medium red clover establishment was negatively impacted by fall applications of mesosulfuron (i.e. Osprey) to winter wheat. Spring herbicide applications (i.e. May) to wheat resulted in 80-100% injury of frost-seeded (i.e. April) medium red clover. Research and extension efforts regarding cover crop and herbicide interactions will continue in Michigan over the next several years.

**Presentation:**

Hill, E., C. Sprague, and K. Renner. 2014. Cover crop and herbicide interactions. A Michigan perspective. North Central Weed Science Society annual meeting. 148. Minneapolis, MN. Oral presentation.

**Cover Crop Publications, Presentations and Outreach.**

Erin Hill ([hiller12@msu.edu](mailto:hiller12@msu.edu)), Christy Sprague ([sprague1@msu.edu](mailto:sprague1@msu.edu)), Karen Renner ([renner@msu.edu](mailto:renner@msu.edu)), Dan Rossman ([rossman@msu.edu](mailto:rossman@msu.edu)) and James Heilig ([heiligja@msu.edu](mailto:heiligja@msu.edu)).

**Manuscripts in Preparation:**

Hill, E. C., K. A. Renner, and C. L. Sprague. Cover crop impact on nitrogen availability and dry bean characteristics in an organic system. Intended journal: Agronomy Journal.

Hill, E. C., K. A. Renner, and C.L. Sprague. Cover crop impact on weed dynamics in an organic dry bean system. Intended journal: Weed Science.

**Scientific Presentations:**

Hill, E. 2014. Cover crop use in the United States. North Central Weed Science Society annual meeting. 147. Minneapolis, MN. Oral presentation.

Hill, E., C. Sprague, and K. Renner. 2014. Cover crop and herbicide interactions: A Michigan perspective. North Central Weed Science Society annual meeting. 148. Minneapolis, MN. Oral presentation.

Hill, E., K. Renner, and C. Sprague. 2014. Impact of cereal rye and red clover on weed seed mortality. Weed Science Society of America annual meeting. 63. Vancouver, BC. Poster.

**Extension and Other Presentations:**

Hill, E. 2014. Introduction to regulated, dicamba-tolerant soybean trials. MSU Weed Science Tour. July 2, 2014. Attended by 240.

Rossman, D., E. Hill, K. Renner, and C. Sprague. 2014. Cover crop influence on organic dry beans: 3 year summary. SunOpta Grower Meeting. April 3, 2014. Attended by 60.

Hill, E. and J. Heilig. 2014. Breeding efforts and cover crop choices for improved organic dry bean production systems in Michigan. eXtension- eOrganic Webinar. March 25, 2014. Attended by 105. Available at <http://www.extension.org/pages/25242/webinars-by-eorganic#.UzGMhvldXhc>.

**Understanding Cover Crop Use in Soybean Production Systems.** Dean Baas

([baasdean@anr.msu.edu](mailto:baasdean@anr.msu.edu)), Eileen Kladvko ([kladvko@purdue.edu](mailto:kladvko@purdue.edu)), Shaun Casteel ([scasteel@purdue.edu](mailto:scasteel@purdue.edu)), Tom Kaspar ([Tom.Kaspar@ars.usda.gov](mailto:Tom.Kaspar@ars.usda.gov)), Don Wyse ([wysex001@umn.edu](mailto:wysex001@umn.edu)), Jim Hoorman ([hoorman.1@osu.edu](mailto:hoorman.1@osu.edu)), Richard Hoorman ([hoormannr@missouri.edu](mailto:hoormannr@missouri.edu)), Matt Ruark ([mdruark@wisc.edu](mailto:mdruark@wisc.edu)), David Clay ([david.clay@sdstate.edu](mailto:david.clay@sdstate.edu)) and Sharon Clay ([sharon.clay@sdstate.edu](mailto:sharon.clay@sdstate.edu)). The MCCC has a one-year project to produce a management guide on cover crop use in soybean production for NCR farmers. Additionally, a prioritized list of future research projects will be developed that will enhance soybean farmers' ability to incorporate cover crop into their farming systems for the North Central Soybean Research Program. A survey was completed on cover crop use before and after soybeans by 164 farmers that use cover crops, 194 farmers that do not use cover crops and 275 CCAs/agronomists. In person interviews were held with eight soybean farmers. Information from the surveys and interviews has been compiled in a cover crop management guide for soybean production that is currently being edited and revised for final publication. Funding source: North Central Soybean Research Program.