<u>NE-1047 Annual Report 2014-2015</u>
NE-1047 Conference Call Meeting Tuesday March 24, 2015
This was our Annual Meeting for 2015
Chairperson: Karen Renner (no new chairperson elected for 2015-2016)

<u>Objective updates:</u>

Objective 1: *Determine how soil conditions affect efficacy and selectivity of cultivation implements for the control of various weed species.* *(Bill and Eric)*

<u>Bill Curran:</u> Clair Keene's thesis project. This work is done and being written up in Claire's thesis with expected defense in late summer 2015. Topic: high-residue cultivation as part of IWM for inter-row weed control in no-till soybean and corn. Residue/no residue did not really impact results (though it was a small amount of residue due to management with herbicides sprayed 1 week before planting, 2-3,000 lbs dry matter). Timing and frequency of cultivation were the most important. High residue cultivators are different than conventional cultivators, intended to use later in the season for control of larger weeds. Results: Run twice to get good weed control. This project was done for 3 years (2 corn; 3 soybean) and so this work is complete. Farmers are not interested in adopting this practice. No-till farmers do not want to disturb the soil at all. Trash wheels included on no-till planter. Banding herbicides worked well; no negative interactions with cover crop residue. They plan to publish a paper in a refereed journal from this research.

*<u>Eric Gallandt</u>**:*** They did 3 years looking at cultivation efficacy vs soil/residue parameters…not a lot of success. They are interested in switching to the potential for natural populations of weed seedlings to be the source of variability in cultivation success (first year of research in 2014). They evaluated the early growth rate of four weed species, cotyledon through 6-8 leaves and included growth rate, root/shoot partitioning, root architecture. They are processing the data to determine how these parameters influence cultivation efficacy or variability in efficacy. Ex. Crabgrass with one leaf has a large root system…efficacy of cultivation drops off quickly as growth in crabgrass progresses. Eric's research is ongoing and collaboration with MSU (Brainard) on cultivation tools – funded for 3 years.

Objective 2: *Determine the reproductive growth stage at which summer annual weeds can be terminated and still produce viable seeds and quantify the effect of method of termination on seed production*. *(Karen, Erin Hill, Mark VanGessel, Robin Bellinder, Eric Gallandt)*
This project was completed in 2014 by all states involved. No future trials related to this project are being conducted in 2015.

*<u>Erin Hill and Karen Renner</u>**:*** A poster was presented at WSSA that included four species with multiple year and location data. A manuscript was submitted to *Weed Science* in June 2015 that combined data from Delaware, New York (Cornell), and Michigan.

Mark VanGessel: Presented an Extension poster at WSSA. The poster focused on the short amount of time between flowering and viable seed formation, and included weed information from all species in this objective. The next step is formulating a fact sheet and having it available on a site such as eOrganic. Mark would like to include photos of the flowering stages of these species. Eric G. will send photos of Hairy galinsoga.

Robin Bellinder: Completed common ragweed data set in 2013 and 2014. The 2014 data was still being processed at the time of the meeting. Since that time processing was completed and the data sent to MSU and included in the publication submitted to *Weed Science*.

Objective 3: *Determine the extent to which soil amendments such as green manures and compost affect seed mortality of various weed species*. *(Karen, Erin Hill, Dan Brainard, Erin Haramoto, Markah Frost (all MSU), Chuck Mohler, Thomas Bjorkman, Carlene Chase)*

Erin Hill and Karen Renner (report): A brief summary of their report is attached, highlighting the differences with the other Universities (shorter pull times, higher cover crop rates, organic system with more disturbances). This work is complete and was a component of Erin Hill's dissertation and is part of a journal article being revised and resubmitted in early July 2015 to *Weed Science*. Karen is continuing work with other amendments and soil incubations under controlled laboratory conditions.

Thomas Bjorkman (report): Their lab group is interested in knowing if a growing cover crop and/or a decomposing cover crop kill weed seeds? Weed seeds included foxtail (ended up being dead) and redroot pigweed. Buckwheat and sorghum sudangrass did not appear to impact weed seed mortality in their research.

Markah Frost, Dan Brainard, Erin Haramoto (report): A report is also attached. The last seed bags were pulled up in 2014 and they are in the final phases of processing seed bags in spring 2015. *Powell amaranth* and large crabgrass were the two weed species studied; cover crops included rye and rye + hairy vetch under two tillage regimes (i.e. strip tillage and moldboard plow). Strip tillage increased longevity of *P. amaranth* seeds compared to moldboard plow; large crabgrass had low viability across all experimental treatments. Markah Frost is continuing work with these two weed species for her MS research.

Chuck Mohler: Treatments include rye, hairy vetch and a bare ground control. Weed species include Powell amaranth, C. lambsquarters, velvetleaf, and giant foxtail. Pull times of seed samples are 6 months, 1.5 and 2.5 years after burial. Therefore this project will not be completed until 2016. Run 1 commenced in fall 2011; Run 2 commenced in fall 2013. Resutsl to date include higher mortality following hairy vetch (proposed mechanism= release of N stimulating germination deep in the soil) and no consistent pattern following rye.

Carlene Chase: Looking at cover crops to suppress weeds during the off season (summer time) and for Sting nematode control in strawberry (see report). Cover crops included: sunhemp, hairy indigo, American joint vetch, and short-flower rattlebox. Good results for weed suppression, in addition to data analysis did an evaluation of stakeholder interest. They were interested in these cover crops and mixtures. Stakeholders want a cover crop that they can get $$ for. Last year they used the cover crops in a 4-way mixture and also included sesame. Sunhemp dominated the mix.

MINUTES **NE-1047 Conference Call Meeting**
Tuesday, March 24, 2015
11:30 am EST

Meeting convened at: 11:35 am

Members attending: Erin Hill, Kevin Gibson (past chair 2014), Chuck Mohler, Robin Bellinder, Toni DiTommaso, Russ Hahn, Steven Mirsky, Carlene Chase, Alan Taylor, Eric Gallandt, Bill Curran, Markah Frost (Brainard group), Thomas Björkman, Mark VanGessel, and Karen Renner (Chair 2015)

Members not attending: Erin Haramoto, Dan Brainard, Fred Servello

Objective updates:
Objective 1: *Determine how soil conditions affect efficacy and selectivity of cultivation implements for the control of various weed species. (Bill and Eric)*

Bill Curran (poster): Clair Keene thesis project. This work is done and being written up in Claire's thesis with expected defense in late summer 2015. Topic: high-residue cultivation as part of IWM for inter-row weed control in no-till soybean and corn. Residue/no residue did not really impact results (though it was a small amount of residue due to management with herbicides sprayed 1 week before planting, 2-3,000 lbs dry matter). Timing and frequency of cultivation were the most important. High residue cultivators are different than conventional cultivators, intended to use later in the season for control of larger weeds. Results: Run twice to get good weed control. This project was done for 3 years (2 corn; 3 soybean) and so this work is complete. Farmers are not interested in adopting this practice. No-till farmers do not want to disturb the soil at all. Trash wheels included on no-till planter. Banding herbicides worked well; no negative interactions with cover crop residue. They plan to publish a paper in a refereed journal from this research.

Eric Gallandt: They did 3 years looking at cultivation efficacy vs soil/residue parameters…not a lot of success. They are interested in switching to the potential for natural populations of weed seedlings to be the source of variability in cultivation success (first year of research in 2014). They evaluated the early growth rate of four weed species, cotyledon through 6-8 leaves and included growth rate, root/shoot partitioning, root architecture. They are processing the data to determine how these parameters influence cultivation efficacy or variability in efficacy. Ex. Crabgrass with one leaf has a large root system…efficacy of cultivation drops off quickly as growth in crabgrass progresses.

Objective 2: *Determine the reproductive growth stage at which summer annual weeds can be terminated and still produce viable seeds and quantify the effect of method of life-termination on seed production.*

Erin Hill and Karen Renner: We presented our poster from WSSA. This work is done and is currently in the process of being submitted as a manuscript to *Weed Science* in April 2015.

Mark VanGessel: Presented poster from WSSA. The poster focused on the short amount of time between flowering and viable seed formation, and concluded that there are about 2 weeks to control weeds after flowering before seeds form. Next step is formulating a fact sheet and make it available on a site such as eOrganic. Mark would like to include photos of the flowering stages of these species. Eric G. will send photos of Hairy galinsoga. This project was completed in 2013. No future trials related to this project are projected for 2014.

Robin Bellinder: Completed common ragweed data set in 2013 and 2014. The 2014 data is still being processed. She is interested in the possibility of included the common ragweed data set in the MSU and DE publication (common ragweed was not a species in MI or DE).

Objective 3: *Determine the extent to which soil amendments such as green manures and compost affect seed mortality of various weed species*.

Erin Hill and Karen Renner (report): We gave a brief summary of our report, highlighting the differences with the other Universities (shorter pull times, higher cover crop rates, organic system with more disturbances). This work is complete. It was included in Erin Hill's dissertation and was recently submitted as part of an article to *Weed Science*.

Thomas Bjorkman (report): Gave a summary of his report. They were interested in knowing if a growing cover crop and/or a decomposing cover crop kill weed seeds? Weed seeds included foxtail (ended up being dead) and redroot pigweed. Buckwheat and sorghum sudangrass did not appear to impact weed seed mortality in their research.

Markah Frost, Dan Brainard, Erin Haramoto (report): Report will be sent out to the group was sent out at 3 p.m. today. The last seed bags were pulled up in 2014 and they are in the final phases of processing seed bags. *Powell amaranth* and large crabgrass were the two weed species studied; cover crops included rye and rye + hairy vetch under two tillage regimes (i.e. strip tillage and moldboard plow). Strip tillage increased longevity of *P. amaranth* seeds compared to moldboard plow; large crabgrass had low viability across all experimental treatments. Faucets of this project may continue, but they are uncertain at this time.

Chuck Mohler (slides): Run 1 done, Run 2 underway but will not be done until spring 2016.

- **Trtmts-** Rye, hairy vetch, bare ground control (planted in same plots in all years)
- **Species-** Powell amaranth, C. lambsquarters, velvetleaf, giant foxtail

- **Pull times-** 6 months, 1.5 and 2.5 years after burial (Run 1 fall 2011, Run 2 fall 2013)
- **Results**
    - Mortality often higher following hairy vetch (proposed mechanism= release of N stimulating germination deep in the soil)
    - No pattern following rye, inconsistent
- **Questions to the group**
    - Is the statistical analysis appropriate (i.e. logistic regression)?
        - Convert to % of initial (% mortality)- Erin Hill and Bill
        - Eric- Logistic regression, doesn't require replications, more x values is what is wanted.
        - How do we know we have enough x values to compensate for replications?
        - Steven- modeled as a % of the total, if the span of x values desired isn't covered then it would be appropriate
        - Carlene- analyzing count data using Proc GLIMMIX (Chuck using GENMOD)
        - Conclusion: need to consult with a statistician on this data set

Carlene Chase- Initially had bags in the ground, but lack of personnel led to dismissing the project. Currently working on another related project, looking at cover crops to suppress weeds during the off season (summer time) and for Sting nematode control in strawberry (see report emailed out). Cover crops included: sunhemp, hairy indigo, American joint vetch, and short-flower rattlebox. Good results for weed suppression, in addition to data analysis did an evaluation of stakeholder interest. They were interested in these cover crops and mixtures. Stakeholders want a cover crop that they can get $$ for. Last year they used the cover crops in a 4-way mixture and also included sesame. Sunhemp dominated the mix.

<u>**Annual report**</u> **is due 60 days following the annual meeting**. Kevin sent a report in for 2013-2014. Karen needs to send in the report for 2014-2015 by May 25 <u>if there is no summer annual meeting</u>. This project terminates in September 2016. **Someone from this group will need to chair the group in 2016 and write the final report.** If the group plans to rewrite a renewal – this should be started in July/August of this year with the renewal turned in spring 2016.

<u>**Summer meeting:**</u>

Who can go? What dates work well? Where? Focus on future direction.

Summary: Reaction not overwhelming to continue. The number of people who would participate depends on the focus area. It sounded like we need to float project ideas around and then based on who is interested in setting up a meeting time and place, if enough interest is generated.

Do we want to collaborate or merge with NC1191 group?
Summary: Uncertain if we want to collaborate. It would depend on their chosen focus.

Individual comments

Eric: Enthusiasm is high during the writing year, then without extra support we aren't able to carry out all of the plans. Interest depends on the focal area. Keeping it very focused is important.

Mark: Like idea of concept, rewarding, but moving forward we need to write a proposal that even those with limited resources could participate and contribute. Keep it focused so that when we are all done the outcomes align and can be written together. Maybe just have one objective with a uniform protocol. We need to be able to come out of this with a manuscript.

Chuck: Does not plan to participate; technically retired for the past 4 years.

Toni: Cover crop impact on weed seed mortality was not significant enough to reduce the weed seed bank. He doesn't want to keep on with this portion of the project because of the results.

Russ: Unlikely to participate in future projects.

Bill: Inquired about what the NC group was doing.

Steven: Happy to participate if the subject matter is of interest. There is probably no need to continue with the seed decay portion. He would like a simple common experiment. Summer meeting would work, depends on where. Beltsville would be good.

Alan: Enjoys multi-state projects and sees the benefits. Some funding opportunities come to them as a result of participating in the multi-state project. Specifically participated because 2 of 3 objectives had a seed component which is why he was invited on. If the new focus is non-seed, Alan will not likely participate.

Carlene: Would rather spend time working on a grant together. Same comment that focus needs to be simple. Focus would need to be applicable to FL cropping systems. Would like to collaborate, but is not counting on it because of the differences.

Dan/Markah: Get in touch with him in mid-May to see his interest in future participation.

Kevin: His interest is waning. Initially had resources, but couldn't continue. Future participation would really depend on what the topic was.

Chuck: Propose an idea, send it around, see who is interested, and then those that are interested need to rally together.

Erin/Chuck: What are we already doing that would be of interest with multiple locations?

Carlene: Has interest in developing weed seed suppressive soils over time. Can we do it? Maybe we aren't affecting the soil microbial biomass as much as we would like to in the short-term, but in long-term we may. Interested in soil health over time, how does this impact the weed suppressiveness of the soil over time? After 4 years there may be additive results. Look at reduced tillage practices and expect that it will have longer lasting impacts. Cover crop mixtures also of interest, but will have to work well in the south as well as in the north.

Meeting concluded at: 1:05 pm EST

Minutes submitted by Erin Hill

NE-1047 Report for 2014-2015
Karen Renner and Erin Hill
Department of Plant, Soil, and Microbial Sciences, Michigan State University

Objective 3: Determine the extent to which soil amendments such as green manures and compost affect seed mortality of various weed species.

Publications and Presentations:

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

Hill, E. K. Renner, and C. Sprague. 2015. From seeds to weeds: Factors influencing organic weed management through the lifecycle. Michigan State University Organic Reporting Session. East Lansing, MI. Attended by 50. Invited

Hill, E. K. Renner, and C. Sprague. 2015. Quantifying the impacts of cover crops on organic dry beans. Organic Agriculture Research Symposium, La Crosse, WI and live broadcast on eXtension-eOrganic. Attended by 75.

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.

Methods

Cover crop treatments:

- Medium red clover
- Cereal rye
- No cover

Summer annual weed species studied:

- Common lambsquarters
- Giant foxtail
- Velvetleaf

Pull timings: 0, 1, 2, 4, 6, 12 months after cover crop incorporation (MAI)

Details:

To determine the influence of cover crops on weed seed decay, a sub-experiment was conducted in 2012 and 2013 within in larger organic experiment detailing the impact of cover crops on soil nitrogen dynamics, dry bean characteristics and yield, and weed dynamics at the Michigan State University (MSU) Horticultural Teaching and Research Center (42.67^{0}N, 84.48^{0}W) (2012) and the Agronomy Farm (42.71^{0}N, 84.47^{0}W) (2013). The cover crop treatments assessed were medium red clover (*Trifolium pratense* L. var. 'Marathon'), cereal rye (*Secale cereale* L. var. 'Wheeler'), and no cover. Fresh seed of common lambsquarters (*Chenopodium album* L.), giant foxtail (*Setaria faberi* Herrm.), and velvetleaf (*Abutilon theophrasti* L.) were collected from MSU in the early fall of each year. Initial viability of the seed lots was determined through tetrazolium chloride testing (Peters 2000). Two hundred weed seeds were buried with 100 g of white silica sand in no-seeum mesh bags (Outdoor Wilderness Fabrics, Nampa, ID), 10 by 10 cm. Bags were buried in the cover crop plots in the fall at a depth of 15 cm. Burial at this time exposed seeds to seasonal fluctuations in temperature and soil moisture and any cover crop root leachates. Enough bags were buried to allow for six removal times at 0, 1, 2, 4, 6, and 12 months after cover crop incorporation (MAI), with four replications for each weed species and removal time combination. In the spring, all bags were excavated immediately prior to cover crop incorporation. One set of bags was analyzed for overwinter seed mortality (0 MAI), while the other sets of seed bags were mixed with a high rate of the cover crop biomass (fresh, chopped shoot and root material, equivalent to 6.2 g of dry biomass per bag) and placed in new mesh bags. Cover crop biomass added to the mesh bags was based on the assumptions that: a) 600 g m^{-2} dry cover crop biomass can be produced by clover and rye, b) cover crops can be uniformly incorporated into the soil profile, and c) a 15 cm hectare furrow slice of soil weighs approximately 2,240 Mg. A more typical quantity of dry biomass added to 100 g of sand in each bag would have been 0.3 g; however we considered uniform cover crop incorporation to be unlikely, and we were interested in mimicking activity at microsites with high concentrations of cover crop. Samples in the no cover treatment were also repackaged in new mesh bags. All repackaged seed bags were buried for temporary storage adjacent to the study site in the same field to allow for soil preparation and planting of the dry bean crop. Immediately after dry bean planting, the seed bags were returned to their respective cover crop plots and buried individually to a depth of 15 cm using a Miltona PowerStroke cup cutter (Maple Grove, MN). Bags were placed in the dry bean row to avoid damage due to cultivation; bean plants emerging adjacent to the seed bags were terminated at VC. At each removal time, bags were excavated and air dried in the laboratory. Samples were then sieved and sorted by hand to separate seeds from the sand and organic debris. Intact seeds retrieved were counted and viability was determined using a combination of germination (dark, 25 C) (Hill et al. 2014) and tetrazolium chloride testing. Seed mortality percentages were calculated as follows (Equation 1):

$$\%\,Seed\ mortality_{x\,MAI} = \left(\frac{(200*\%\ initially\ viable\ seed) - \#\ viable\ seed_{x\,MAI}}{(200*\%\ initially\ viable\ seed)}\right) * 100 \quad [1]$$

Results

There was not an interaction between the time of seed bag retrieval and cover crop treatment; therefore main effects are presented separately. However, there was a significant interaction between the main effects and year, thus years are presented separately within each main effect. Part of that interaction occurred because we were unable to recover the 6 MAI bags in 2013 due to the extended period of snow cover (2013-2014).

Weed Seed Mortality over Time. Over the course of our two year experiment the overwinter weed seed mortality (0 MAI), before cover crops were incorporated and added to the seed bags, ranged from 9 to 47% for common lambsquarters and velvetleaf, and from 22 to 72% for giant foxtail (Table 1). In a two-year regional study on weed seed persistence, the average overwinter mortality (October through April) of common lambsquarters, giant foxtail, and velvetleaf was 26, 28, and 24% and maximum observed mortality was 95, 95, and 92%, respectively (Davis et al. 2005b). Our 2013 giant foxtail seed (i.e. 72% overwinter mortality) was collected at KBS during 2012, when precipitation was low, supporting previous research where the growing conditions of the maternal plants impacted giant foxtail seed mortality (Kegode and Pearce 1998; Schutte et al. 2008). The influence of maternal moisture availability on giant foxtail seed development and persistence has not been studied, however in oats, water-stress of maternal plants shortened the period of dormancy in the progeny (Sawhney and Naylor 1982), which under the conditions of our study may have led to fatal germination. In contrast, the 2013 velvetleaf seed had reduced overwinter mortality compared with 2012, confirming that maternal effects are species specific (Schutte et al. 2008). The primary dormancy of velvetleaf lasts longer when maternal plants grow in warm and dry conditions (Cardina and Sparrow 1997). An alternative explanation for our observations may be that giant foxtail was more sensitive to overwinter or spring storage conditions or potential pathogen exposure in 2012-2013, increasing the mortality of giant foxtail, but not common lambsquarters and velvetleaf.

Seed mortality of all species, with the exception of 2013 velvetleaf, increased 12 to 40% in the 1 MAI (Table 1). The lack of an interaction between cover crop and retrieval time may indicate that soil disturbance during bag retrieval, repackaging with cover crop residue, and bag re-burial, was more likely the cause of increased fatal germination. If the cover crop amendment increased seed mortality we would have expected a retrieval time by cover crop interaction for 1 MAI since no cover crop amendment was added to the no cover control bags. In previous research, common lambsquarters germination was positively influenced by exposure to light (Henson 1970), and light and dark tillage in late-May in Minnesota increased emergence of common lambsquarters, velvetleaf, and giant foxtail (Buhler 1997).

Beyond 1 MAI, weed seed mortality continued to increase, more so in 2012 than 2013 in spite of spring flooding during storage in 2013 (Table 1). Common lambsquarters seed mortality increased between 1 and 4 MAI in 2012 and 1 and 12 MAI in 2013. Giant foxtail mortality increased between 1 and 6 MAI in 2012 only, and velvetleaf seed mortality increased between 1 and 4 MAI in 2012 only. Maximum mortality rates for common lambsquarters, giant foxtail, and velvetleaf were 74, 100, and 49%, respectively.

Cover Crop Impact on Weed Seed Mortality. When pooled across sampling times, there were no differences in weed seed mortality between the clover and no cover control treatments in 2012. However, in 2013 red clover increased the mortality of common lambsquarters by an average of 25% compared with rye and the no cover control (Table 2). Mohler et al. (2012) attributed differences in weed seedling emergence following the incorporation of a different legume, pea (*Pisium sativum* L.), to the increase in pathogenic fungi attack on the weed seeds and seedlings. Cereal rye increased the persistence of velvetleaf and giant foxtail seed, by up to 12 and 6%, respectively in 2012 compared with the no cover control. Additions of high C:N plant material, such as the rye in our research (30:1), to the soil has increased weed seed persistence in other studies (Davis et al. 2005b, 2006; Shem-Tov et al. 2005; Davis 2007), possibly because of N limitations that reduce microbial activity (Davis et al. 2006). No effect of rye was observed in 2013, however seed mortality for giant foxtail was very high (91%) and velvetleaf was low (8%). Abiotic and biotic differences in the soil environment may both be important factors contributing to the observed changes in weed seed mortality; further research is needed on the influence of soil amendments, including cover crop residues, on weed seed mortality in agroecosystems.

Tables

Table 1. Weed seed mortality over time for 2012 and 2013. Values are averaged across cover crop treatments (i.e. red clover, cereal rye, and no cover crop control treatments).

		Weed species		
Year	Time	Common lambsquarters	Giant foxtail	Velvetleaf
	MAI[a]	— Percent mortality (%) —		
2012	0	47	21	23
	1	59	71	40
	2	59	78	44
	4	74	79	49
	6	69	83	47
	12	60	87	48
	LSD[b]	*10*	*9*	*8*
2013	0	20	72	9
	1	34	93	5
	2	44	95	10
	4	46	97	10
	6	-	-	-
	12	66	100	7
	LSD	*12*	*10*	*NS*

[a] MAI= months after cover crop incorporation

[b] Fisher's protected LSD ($P \leq 0.05$).

Table 2. Weed seed mortality as influenced by cover crop in 2012 and 2013. Values are averaged across all pull times (i.e. 0 to 12 months after cover crop incorporation).

		Weed species		
Year	Cover crop[a]	Common lambsquarters	Giant foxtail	Velvetleaf
		— Percent mortality (%) —		
2012	No cover	62	73	43
	Clover	65	75	47
	Rye	57	61	36
	LSD[b]	*NS*	*10*	*6*
2013	No cover	36	96	6
	Clover	58	86	9
	Rye	31	92	9
	LSD	*9*	*NS*	*NS*

[a] Clover= medium red clover, radish= oilseed radish, rye= cereal rye, no cover= weedy control.

[b] Fisher's protected LSD ($P \leq 0.05$).

References

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Shem-Tov S, Klose S, Ajwa S, Fennimore SA (2005) Effect of soil carbon: nitrogen ratio and organic matter amendments on seedbank longevity. Weed Sci Soc Am Abs 45:324 [Abstract]

NE-1047 Report for 2014 -2015
Dan Brainard and Erin Haramoto
Updated by Markah Frost, 3/24/2015
Department of Horticulture, Michigan State University

Objective 3: Effects of cover crops on weed seed survival in the soil

Methods

Overview. Survival of buried weed seeds (*Amaranthus powellii* and *Digitaria sanguinalis*) was evaluated in a long-term trial examining the effects of cover crops (none, rye or rye-vetch) and tillage (moldboard plow vs strip-till) on weeds in a three-year vegetable crop rotation (sweet corn (2009, 2012): snap beans (2010, 2013): winter squash (2011, 2014)). Cover crop and tillage treatments have been imposed in the same plots since 2009. Seeds were buried following winter squash harvest in fall 2011, exhumed in spring 2012, 2013, and 2014 and tested for viability. Sufficient additional bags have been buried to examine survival for 2 additional years. Additional details on our methodology were provided in our 2013 annual report.

2013 exhumation and viability testing. One bag of each species from each plot was exhumed on 29 May 2013. Bags were stored at 4°C until they were opened, spread into a thin layer, and dried at room temperature. Seeds were separated from the sand and residue by sieving through a 500 µ sieve and stored at room temperature until viability testing. Seeds of both species were then germinated at 30°C with 2 µM GA. Ungerminated seeds were assessed for viability by a combination of squeeze testing and TZ testing. Seeds were characterized as germinated, dormant (did not germinate but were TZ viable), or dead; germinated and dormant seeds were considered viable.

Reburial. In moldboard plow treatments, all remaining bags were pulled prior to spring tillage, filled with a fixed amount of cover crop residue, and re-buried following tillage and planting the next day. Bags were filled with rye and vetch residue that had been collected prior to termination (15 May 2013), dried down, and coarsely ground in a Wiley mill. Pieces of ground residues were approximately 5-10 mm long. Experiment-wide, dry rye biomass averaged 2400 kg/ha in rye only plots and 2940 kg/ha with 560 kg/ha vetch biomass in rye/vetch plots. For rye plots, we added 0.13 g of dry rye residue per bag; for rye and vetch plots we added 0.13 g dry rye and 0.027 g dry vetch residue.

2014 exhumation and viability testing. All bags of each species from all plots were recovered on June 5th, 2014. These bags were opened and dried at room temperature in manila envelopes. Seeds of both species were identified and removed from the other debris before being germinated at 30°C. AMAPO was germinated using 2 µM GA while DIGSA was germinated using de-ionized H_2O. Seeds remaining ungerminated were tested for viability by a combination of squeeze testing and TZ testing. Seeds were characterized as germinated, dormant (did not germinate but were TZ viable), or dead; germinated and dormant seeds were considered viable. Germination and TZ testing is currently underway with three replicates of AMAPO and two replicates of DIGSA having been completed.

2013 Results and Discussion

In 2013, more viable AMAPO seeds were recovered from ST than from MBP; 43% of AMAPO seeds recovered in ST were still viable while only 4% of those recovered from MBP were viable (Figure 1). Within each tillage type, the cover crop species did not affect AMAPO viability. Seeds within MBP were excavated and mixed with cover crop residue (or just mixed to stimulate tillage for plots without cover crops) in June 2012, while those in ST were buried continuously since November 2011. It is possible that removal and reburial of seeds in MBP treatments promoted more fatal germination than ST treatments due to greater exposure to light, oxygen or other germination stimuli. In 2013, no effects of tillage or cover crop on DIGSA viability were detected, and survival was less than 10% in all cases (Figure 2). Large variability in DIGSA survival—especially in strip-tillage treatments—limited our ability to detect significant differences.

2014 Results and Discussion

In 2014 similar results were seen as in 2013 with more viable AMAPO seeds recovered from ST than from MBP plots. In MBP less than 1% of AMAPO seeds recovered were viable while in ST viable seeds constituted 33% of those recovered (Figure 1). Seeds within MBP were excavated and mixed with cover crop residue (or just mixed to stimulate tillage for plots without cover crops) in June 2012 and May 2013, while those in ST were buried continuously since November 2011. It is possible that removal and reburial of seeds in MBP treatments promoted more fatal germination than ST treatments due to greater exposure to light, oxygen or other germination stimuli. It is worth noting that in the rye-vetch treatments the vetch did poorly which resulted in primarily rye stands. For this reason it is not surprising that percent viable seed recovered was similar in rye and rye-vetch treatments. Also, 2014 DIGSA seed viability was less than 1% for both MBP and ST plots (Figure 2).

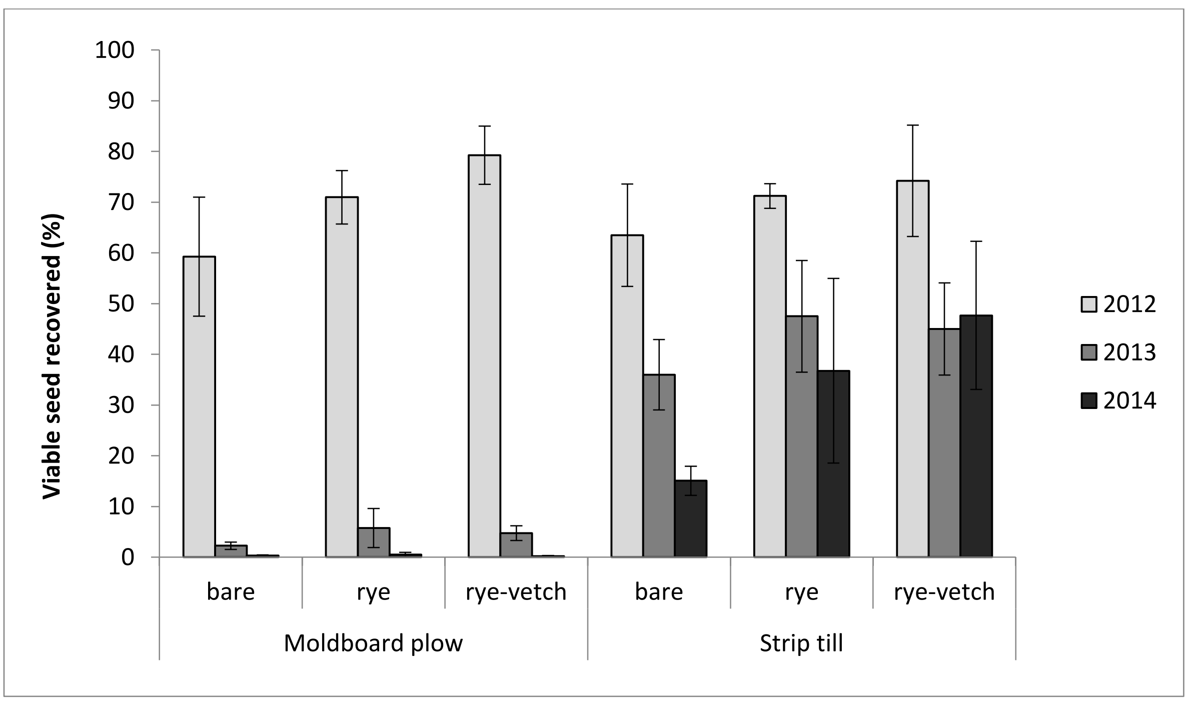

Figure 1. Mean (±se) survival of seeds of *A. powellii* (AMAPO) buried in fall 2011 and recovered in spring 2012, spring 2013, and late summer 2014. In 2012, there were no significant differences between treatments at α=0.05. In 2013, AMAPO emergence was affected by tillage (p=0.02), but not by cover crop. In 2014, it appears that rye and rye-vetch treatments may have increased AMAPO seed survival.

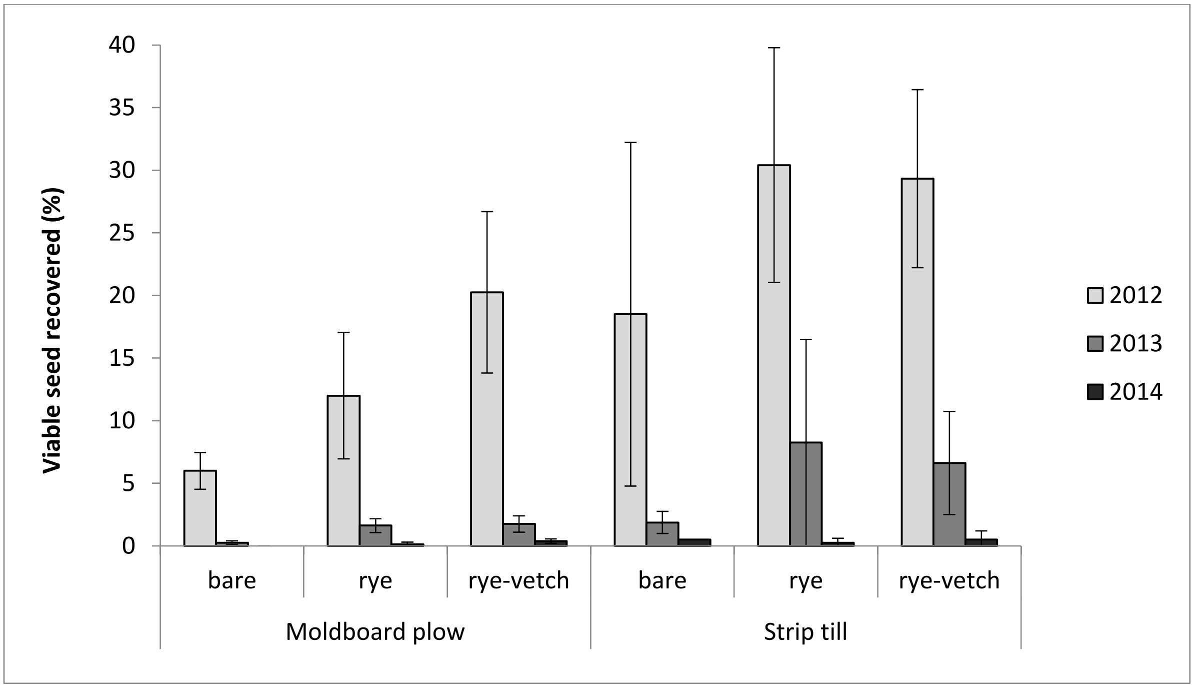

Figure 2. Mean (±se) survival of seeds of *D. sanguinalis* (DIGSA) buried in fall 2011 and recovered in spring 2012, spring 2013, and late summer 2014. Within years 2012 and 2013 there were no significant differences between treatments at α=0.05.

Cornell report to the NE1047 technical committee for 2014-2015

Ecological Bases for Weed Management in Sustainable Cropping Systems

Start date: 10/1/12
End date: 9/30/16
Project no.: NYC-125800
MultiState no.: NE1047

Project Director: Antonio DiTommaso
ad97@cornell.edu
Performing department: Section of Soil and Crop Sciences, School of Integrative Plant Sciences

Participants

Role	Faculty and non—students	Undergraduates	Graduate students	Post-doctoral Students	Computed total by role
Scientist	0.4				0.4
Professional			0.7		0.7
Technical	0.2	0.7		0.6	1.4
Administrative					
Other					
Contributed total	0.6	0.7	0.7	0.6	2.6

Target Audience
Small and large scale field crop and vegetable farmers, organic and conventional; extension educators; agricultural scientists

Products and publications

Bellinder, R., J.B. France. Evaluating Herbicide Programs for Zone-Till Dry Beans. 2014. Northeastern Weed Science Society Proceedings, Vol. 68.

Bellinder, R. Evaluating New Herbicides for Specialty Crops: Snap, Dry, Lima Beans, Beets, Carrots, Cabbage, Peas, Potatoes, Sweet Corn, and Tomatoes. Proceedings Empire State Fruit and Vegetable EXPO, January 2014.

Caldwell[1], B., C. L. Mohler, Q. M. Ketterings, and A. DiTommaso. Yields and profitability during and after transition in organic grain cropping systems. Agronomy Journal 106:871-880.

Clements, D.R., A. DiTommaso, and T. Hyvönen. 2014. Chapter 2. Ecology and Management of Weeds in a Changing Climate. In: B.S. Chauhan and G. Mahajan, eds. Recent Advances in Weed Management. Springer Science+Media, New York, NY, USA pp. 13-37.

Kikkert, J.R., and R. Bellinder. Documentation and Management of Linuron-Resistant Weeds in Processing Carrot Fields in New York. 2014 Northeastern Weed Science Society, Proceedings, Vol. 68.

Other products/outputs

Activities: Some weed species can produce seeds after the plant is killed even if the seeds are not yet mature at the time of death. An experiment to determine how developmental stage and killing method affects the subsequent development of seeds of common ragweed was conducted in 2013 and repeated in 2014. The seeds from the 2013 experiment were tested for germination and viability during the 2014 project year. Experiment to determine whether incorporated cover crops of rye or hairy vetch affect the survival of common weeds of the northeastern U.S.A. were initiated by burying bags of seeds in Nov. of 2011 and 2013. The latter second initiation (2013) occurred during the 2014 project year. Bags were recovered in May 2014 and either seeds were tested for viability or mixed with freshly chopped cover crop material and reburied in plots in which the cover crops had just been incorporated. Events: Bellinder and Hahn each held field days in July for CCE educators, farmers, students, and company representatives. Each was attended by about 50 people. Bellinder had meetings with grower advisory groups for all processing vegetable farmers (peas, beets, carrots, sweet corn, and snap, dry and lima beans). Total number of participants was 150. A major area of discussion in all of these meetings was that of developing plans for managing weed seed banks. She also had a meeting with vegetable growers in Delaware County. This is a county that does not usually come to Cornell activities. The focus was a review of multiple weed management strategies, including mechanical, natural products, weed seed management etc. Mohler gave two talks at a grower's meeting in Canby,, Oregon, a research seminar at Oregon State University in Corvallis, Oregon, and a half day workshop for growers and extension personnel in Aurora, Oregon.. All of these dealt with ecologically based weed management methods emphasizing prevention of seed production and management of weed seed banks.

Accomplishments

What was accomplished under these goals?

Obj. 2. During the 2013 growing season a naturally growing field of ragweed was used as the trial area. Ragweed plants were harvested at 50% bloom on 8/23 and then again at early seed development on 9/5 and at late seed development on 9/19. At each timing, the plants were chopped, treated with glyphosate, or uprooted (to simulate hand weeding). Plant materials were enclosed in mesh bags and left in the field until early Nov. Following cold storage 100 seeds from each of 4 replicate plots were tested for germination. Seed viability was determined by germination followed by tetrazolium testing of ungerminated seeds during the winter of 2014. Germination did not differ among termination methods. **Growth stage at termination did affect percentage seed viability. Average seed viability was 32%, 59% and 75% at the 8/23, 9/5, and 9/19 dates, respectively.** The trial was repeated during the summer of 2014 and the germination studies will occur during the winter of 2015. Obj. 3. In Nov. 2011 we buried mesh bags of common lambsquarters (LQ), Powell amaranth (PA), velvetleaf (VL) and giant foxtail (GF) seeds mixed with sand at 15 cm in plots of rye, hairy vetch or a bare control. The experiment was replicated five times. Bags were recovered in May 2012, 2013 and 2014 and either evaluated for viability or the contents mixed with the equivalent of 600 dry g per sq m of chopped fresh cover crop and reburied. All plots were tilled and planted with sorghum-sudangrass (SS) prior to reburial of bags. Each year, sorghum-sudangrass was harvested as forage in Sep and plots were no-till planted with the same cover crops. A second set of seed bags was buried in Nov 2013 and one subset recovered for testing in May 2014. **Viability did not differ between treatments in samples newly buried from 2011-2012 and 2013-2014, indicating minimal effect of cover crop roots alone on seed survival.** Seeds were in contact with cover crop shoot material during the periods 2012- 2013 and 2013-2014. This gave 8 species-period combinations but survival of VL 2012- 2013 could not be computed because, for unknown reasons, fewer seeds were recovered in 2012 than in 2013 in all plots. In 6 of the7 remaining species-period combinations, **survival in hairy vetch residue was lower than survival in the controls**. The exception was GF for 3012-2013, which showed no difference among treatments. **Rye residue significantly increased survival as often as it decreased survival, with no species showing a consistent pattern.** After 2.5 years in the soil, few seeds of VL, PA, or LQ were dormant. Nearly 55 percent of GF seeds were dormant.

What opportunities for training and personal development has the project created?
In this project year, six undergraduates and a post-doctoral fellow participated in project field and lab-based tasks and enhancing their knowledge and skill sets.

How have the results been disseminated to communities of interest?
Bellinder and Hahn each held field days in July for CCE educators, farmers, students, and company representatives. Each was attended by about 50 people. She met with grower advisory groups for all processing vegetable farmers (peas, beets, carrots, sweet corn, and snap, dry and lima beans). Total number of participants was 150. A major area of discussion in all of these meetings was that of developing plans for managing weed seed banks. She was invited to a vegetable growers' meeting in Delaware County. This is a county that doesn't usually come to Cornell activities. The focus was a review of multiple weed management strategies, including mechanical, natural products, weed seed management etc. Mohler gave two talks at a grower's meeting in Canby,, Oregon, a research seminar at Oregon State University in Corvallis, Oregon, and a half day workshop for growers and extension personnel in Aurora, Oregon.. All of these dealt with ecologically based weed management methods emphasizing prevention of seed production and management of weed seed banks.

What do you plan to do during the next reporting period to accomplish the goals?
Plants from the 2014 termination study were collected during the 2015 project year (fall 2014). Seed from these plants will be tested to determine seed production in the several treatments. Winter cover crops of hairy vetch and rye and a summer crop of sorghum-sudangrass will continue to be grown on the buried seed plots. The second set of buried seed bags from the 2013 initial burial will be recovered and cover crops mixed into the remaining bags prior to re-burial. These will be recovered in 2016.
Table 1. Probability of seed survival over various intervals in the seed survival in cover crop amended soil experiment, 2011 initiation. The first three data columns indicate probability of surviving from initiation of the experiment in Nov. 2011 until late May of the indicated year. The last two data columns indicate survival from May until the following May of the indicated

years. Differences among survival probabilities were estimated by logistic regression (SAS Proc Genmond) and the probabilities are back-transformed logits. Logistic regression models for intervals beginning in 2011 include replication. Models for the intervals 2012 to 2013 and 2013 to 2014 was included by large variation in counts among replications. Survival from 2012 to 2013 could not be estimated for velvetleaf because, for unknown reasons, seed counts in 2013 were consistently greater than in 2012. Values within a species and survival interval that share the same letter do not differ at $P < 0.05$. Letters in parentheses indicate values that do not differ at $P < 0.1$ and are given in this internal report to indicate possible trends.

	To 2012		To 2013		To 2014		2012 to 2013		2013 to 2014	
Velvetleaf										
Control	0.48	a	0.58	b	0.57	a	NA		0.99	a
Rye	0.51	a	0.70	a	0.55	a	NA		0.79	c
Vetch	0.51	a	0.61	b	0.57	a	NA		0.93	b
Giant foxtail										
Control	0.81	a	0.25	a	0.06	b	0.28	a	0.31	b
Rye	0.85	a	0.28	a	0.12	a	0.32	a	0.42	a
Vetch	0.96	a	0.31	a	0.05	b	0.32	a	0.18	c
Powell amaranth										
Control	0.80	a	0.40	a	0.13	a	0.51	a	0.33	b
Rye	0.89	a	0.18	b	0.14	a	0.22	c	0.74	a
Vetch	0.90	a	0.30	ab (a)	0.03	a (b)	0.34	b	0.11	c
Common lambsquarters										
Control	0.65	a	0.48	a	0.39	a	0.76	a	0.81	b
Rye	0.76	a	0.37	ab	0.34	a	0.50	b	0.94	a
Vetch	0.72	a	0.25	b	0.16	b	0.37	c	0.64	c

Table 2. Probability of seed survival from Nov. 2013 to late May 2014 and approximate standard errors, 2013 initiation. Values are means of proportion surviving in each of the five replicate plots. Standard errors are only approximate since true standard errors would be asymmetric. As expected, treatments do not appear to differ for any species.

Treatment	2013 to 2014	SE
Velvetleaf		
Control	0.39	0.04
Rye	0.44	0.03
Vetch	0.46	0.07
Giant foxtail		
Control	0.84	0.05
Rye	0.87	0.05
Vetch	0.80	0.04
Powell amaranth		
Control	0.89	0.05
Rye	0.95	0.02
Vetch	0.84	0.05
Common lambsquarters		
Control	0.85	0.06
Rye	0.86	0.10
Vetch	0.97	0.01