Project Title: Systems Strategies for Weed Management on Organic Grain Farms

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Funding provided by CERES Trust: $12,300
Project period: 2011
Report submitted: November 2012

Project Summary

Weed management is commonly identified as the most serious challenge faced by organic grain farmers; yet, discussion with organic inspectors active in the Midwest region consistently indicates that some organic grain farmers are very effective weed maangers. With the support of funding from the Ceres Trust, we used in-depth interviews with 24 organic farmers (and 3 organic crop consultants) recognized for excellent weed management skills to explore the on-farm dimensions of successful weed management. In addition, we conducted 3 field experiments at the WIU Organic research farm to investigate the impacts of tillage intensity and intercropping on weed and crop performance. Lastly, we employed a wide variety of outreach methods including field days, conference presentations, internet forum discussions and a compilation of 9 farmer/consultant profiles titled *Excellence in Organic Weed Management: insights from the field* to share the information gathered through this project.

Problem Addressed

Weed management is commonly identified as the most serious challenge faced by organic grain producers and the biggest deterrent to conventional grain producers considering transitioning to organic production. On-farm observations reveal that some organic grain farmers are clearly more effective weed managers... is this because they use novel practices... or simply integrate common tactics more effectively as part of a focused systems approach to weed management? *Steel in the Field*, published by the USDA's Sustainable Agriculture, Research and Education program, provides an excellent discussion of specific cultivation tools and includes profiles of some of the same farmers that we interviewed. We went a step farther in documenting successful systems strategies (i.e., farmer awareness and operational skill in integrating direct weed control techniques including blind and row cultivation, flaming and manual weed rouging with cultural systems including primary and secondary tillage, nutrient and water management, rotation of cash and cover crops and mechanical and electronic equipment guidance) on 24 organic grain farms recognized for superior weed management. In addition, we used 3 field experiments to provide context for scientific investigation, practical demonstration AND perhaps most important farmer-to-farmer and farmer-to-researcher dialogue about the weed management challenges and opportunities associated with organic no-till and rye intercropping systems.

Methodology

The project consisted of 3 tightly integrated components: 1) documentation of weed management by recognized specialists, 2) scientific investigation at the WIU Organic

Research farm and 3) outreach through field days, conference presentations, internet forum discussions (e.g., http://talk.newagtalk.com/forums/thread-view.asp?tid=248985) and compilation of farmer/consultant profiles.

Documentation of weed management by recognized specialists

24 farmers in 7 Midwestern states (See Table 3) recognized for their successful weed management were interviewed by phone and email using a prepared set of questions (See appendix A). The farmers collectively manage over 26,000 acres of certified organic crops and have over 400 years of experience with organic grain production. Interviews were conducted primarily by Andy Clayton, WIU Organic program research technician and Sarah Heller, student assistant. A high level of understanding of organic farming concepts and vocabulary was necessary to effectively conduct and transcribe the phone interviews.

Complementary field experiments

a) 2 soybean following cover crop studies including no-till systems

b) 1 spring planted cereal rye intercropped with soybeans study

Crop stand counts and yield were measured for all studies along with qualitative assessment of weed abundance and diversity. All data was managed in MS Excel and analyzed using statistical software.

No-till soybean studies

No-till soybean plots were added to 2 soybean experiments for which tillage comparisons were not the primary focus. Experiment 1 was a SARE funded experiment (LNC10-321 – Suppressing soybeans diseases through the use of cover crops). The 5 original treatments (bare fallow, cereal rye, mustard, canola and rapeseed) included conventional tillage prior to planting soybeans. An additional treatment of cereal rye was rolled at anthesis and then no-till planted to soybeans on 7.5" rows using a NT drill. Plots were 10' x 1260' and replicated 3 times. The second experiment to which no-till rye plots were added was an annual ryegrass variety trial (cereal rye was included as a control) with 4 replications. The ryegrass plots were tilled prior to planting soybeans but the cereal rye plots were NT drilled to soybeans on 7.5" rows prior to rolling. All plots were 10' by 150' and were replicated 3 times in a randomized complete block design.

Cereal rye interseeded with soybeans study

Soybeans were planted on 30" rows (180,000 seeds/ac) without cereal rye, with a narrow band of cereal rye seed applied over the row at 2 rates (20 and 40 lbs/a) and with cereal rye broadcast at 60 lbs/a ~ 1 week after planting. The over-the-row bands of rye were applied using a1 row push planter because of mechanical difficulties with the insecticide boxes on our planter. The broadcast applications of rye were done manually, followed by rotary hoeing to incorporate the seed. The plots were 20'x 100' and were replicated 4 times in randomized complete block design. Replications 1 and 2 were on the west side of the experimental field whereas replications 3 and 4 were on the east side.

Results

Weed growth was patchy and relatively low in all plots of the soybean interseeded with cereal rye experiment. There were no clear treatment effects on weed abundance and species richness. In replications 1 and 2 on the east side of the field with higher soil fertility, there was indication of yield loss due to in-row banded rye whereas in replications 3 and 4 on the west side of the field, in-row banded rye appeared to have a negative effect on soybean growth (Table 1). When analyzed across all replications, there were no significant treatment effects on crop yield.

Weeds abundance and species richness was much lower in the no-till plots as compared to the conventional till plots in both experiments. The no-till plots contained low levels of giant and yellow foxtail and very low levels of broadleaf weeds. Soybean yields were significantly higher in the no-till plots than the conventional plots where weed control was poor due to excessive wetness during the first month after planting (Table 2).

Conclusion

This project contributed valuable pieces to a long-term effort to assemble the organic systems strategies for weed management puzzle. Interseeded rye appeared to provide some in-row weed suppression but weed pressure was too low and patchy for these results to be conclusive. Under high fertility conditions, ~ 1 month of in-row competition between rye and soybeans did not appear to negatively impact soybean yield whereas yield suppression may have occurred under lower fertility conditions.

The extreme weather conditions in 2011 (excessive wetness during June and drought during July and August) made weed control challenging in wide row soybeans with pre-plant tillage, rotary hoeing and cultivation. In contrast, similar to 2009 and 2010, soybeans NT drilled into a thick stand of cereal rye established slowly but had relatively low weed pressure and yielded well.

Interviews with recognized organic weed management specialists revealed a diversity of specific tools and techniques but much common ground in terms of attention to detail and concerted effort to start clean and aggressively suppress weed growth throughout the season. Most of the larger scale organic grain producers that we interviewed have adopted or are moving toward using RTK guidance to increase precision in their weed management. The farmers using precision strategies are featured in *Excellence in Organic Weed Management: insights from the field.*

Outreach

In the course of this project, we assembled a loosely knit learning community of specialists in weed management. All collaborating farmers and consultants as well as attendees at the 2012 WIU Organic Farm field day who provided an e-mail address received copies of ***Excellence in Organic Weed Management: insights from the field.*** Insights gained from the interviews and the field experiments were shared at winter meetings in 2012 (e,g., The IL Specialty Crops and Organic conference, MN Organic Conference and The Organic Conference in LaCrosse, WI) and through discussion in internet forums. Communication with the farmer collaborators in this

project is on-going as we move toward additional collaboration related to opportunities for increased precision on organic grain farms.

Table 1: Soybeans with interseeded rye experiment

Rep	treatment	yield (bu/ac)	Trt by field section means	trt means
1	control	47.5	45.7 (west)	45.7
1	rye broadcast (60#/a)	44.7	42.4 (west)	44.9
1	rye banded (20#/a)	37.6	36.2 (west)	40.2
1	rye banded (40#/a)	39.9	37.9 (west)	43.4
2	control	43.9		
2	rye broadcast (60#/a)	40.0		
2	rye banded (20#/a)	34.7		
2	rye banded (40#/a)	35.9		
3	control	43.0	45.6 (east)	
3	60#/a broadcasted	49.0	47.4 (east)	
3	rye banded (20#/a)	46.6	44.2 (east)	
3	rye banded (40#/a)	51.3	49.0 (east)	
4	control	48.3		
4	rye broadcast (60#/a)	45.9		
4	rye banded (20#/a)	41.7		
4	rye banded (40#/a)	46.6		

Table 2: Soybeans following cover crops experiment

rep	cover crop	yield (bu/ac)	trt means (bu/a)	rep means (bu/a)
1	fallow	30.9	33.0	36.7
1	canola	37.0	30.1	
1	mustard	39.4	29.3	
1	rapeseed	32.3	24.8	
1	rye	33.4	24.4	
1	rye/no-till	47.3	42.9	
2	fallow	32.5		26.2
2	canola	24.7		
2	mustard	23.6		
2	rapeseed	21.4		
2	rye	16.0		
2	rye/no-till	38.8		
3	fallow	35.6		29.3
3	canola	28.6		
3	mustard	24.9		
3	rapeseed	20.7		
3	rye	23.6		
3	rye/no-till	42.5		

Table 3: Summary statistics for farmer interview candidates

Town	State	Org. acres	Conv. acres	Yrs. farming	Yrs. org. farming
Panora	IA	1890	0	30	12
Sutherland	IA	300	0	35	13
Jefferson	IA	1800	0	17	13
Dekalb Cty	Il	1600	0	30	15
Maple Park	IL	156	0	28	28
Pana	IL	2500	0	50	20
Paxton	IL	400	0	15	9
Yale	IL	1000	0	35	25
Atkinson	IL	72	0	22	7
Tampico	IL	1700	0	52	12
Maple Park	IL	285	0	36	12
Cerro Gordo	IL	600	1000	40	16
Malta	IL	2400	0	28	13
Roanoke	IN	485	1500	7	7
Caro	MI	2100	100	40	15
Moorehead	MN	2250	0	31	19
Madison	MN	350	0	40	36
Wells	MN	800	0	44	30
Moorehead	MN	900	0	28	14
Clay Cty	MN	1200	0	30	10
Braggadocio	MO	1700	80	39	21
Montrose	MO	560	0	25	14
Middleton	MO	731	0	38	17
Janesville	WI	900	4230	30	23
Totals		26679	6910	770	401

Appendix A: Weed management interview questions for organic grain farmers

Basic biographical and background info:

Name:

Educational background:

Farm location:

Years farming: Years farming organically:

Organic crops and acreages:

Conventional crop and acres if applicable:

Organic certifying agency:

Livestock enterprises:

Standard crop rotation(s) for organic crops

Standard tillage practices for organic crops:

Most challenging weeds in organic fields:

Questions about direct weed control tactics:

o What cultivation tools do you use on your farm? Please briefly describe how you use each tool (crops, timing, adjustment, ground speed, mechanical or GPS guidance...) and your level of satisfaction.

o Do you have any experience with flame weeding? If so, please explain.

o Do you have experience with any "organic" herbicides? If so, please explain. He tried one without any success.

o Is manual labor (e.g., walking beans) part of the weed management on your farm? If so, please explain.

Questions about cropping system strategies for reducing weed pressure:

o What role does primary tillage play within your overall approach to organic weed management?

o What role does crop rotation play within your overall approach to organic weed

management?

o What role do cover crops play within your overall approach to organic weed management?

o Do you use any specific methods of depleting the soil seed bank (e.g., fallow, stale seed bedding...? If so, please describe.

o Do you have any specific clean-up strategies following weed control disasters?

o Do you specifically select crop varieties/hybrids for competitive advantage over weeds?

Additional questions:

o How are your standard organic weed management practices affected by extended wet conditions? Have you developed any effective techniques for controlling weeds organically during wet conditions?

o How different are your weed management practices from other organic grain farmers you know?

o Do you know any organic farmers who seem to be particularly skillful weed managers? If so, what do you think gives them the edge?

o What are your favorite information sources about organic weed management? (e.g., books, conferences, other farms, websites, and etc.)

o Are you considering any new weed management strategies? If so, please explain.

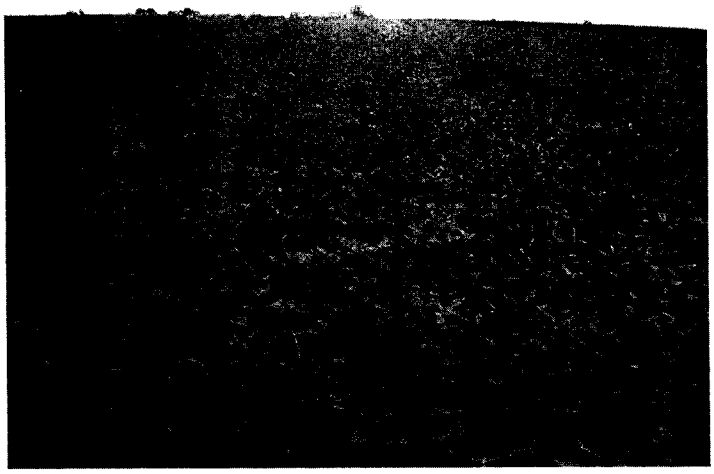
o Are there any specific aspects of organic weed management that you think need more research? If so, please describe?

Do you have any additional comments to share about organic weed management that might benefit other organic farmers?

Appendix B: Photos of field plots at the WIU Organic Research Farm

Soybeans on 30" rows with cereal rye (40 lbs/a) banded over the row. The rye died after the soybeans closed canopy.

The central plot contains soybeans NT drilled (220k/a) into standing cereal rye prior to rolling.



The central plot contains soybeans NT drilled (220k/a) into cereal rye that was rolled prior to drilling. Adjacent plots with much higher weed pressure contain soybeans that were planted on 30" rows and have been rotary hoed and cultivated twice.

Appendix C: Example page from ***Excellence in Organic Weed Management***

Scott Shriver

Educational background
Construction Engineering, Iowa State University

Years farming: 17

Years farming organically: 13

Conventional crops & acres
None.

Organic certifying agency
OCIA (Organic Crop Improvement Association) Chapter 1 of Iowa

Livestock enterprises
None.

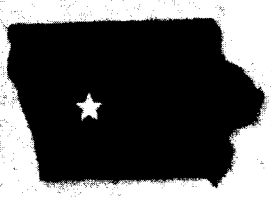
Standard crop rotation for organic crops

- Year 1: Corn
- Year 2: Soybeans
- Year 3: Corn
- Year 4: Soybeans
- Year 5: Small Grain

Standard tillage practices for organic crops
Scott believes that nothing is "standard". At his farm, they do a lot of tillage with 40'-wide equipment to manage residue, incorporate cover crops, and control weeds.

Most challenging weeds in organic fields
Foxtail and waterhemp.

Farm location
Jefferson, IA



Organic crops & acreages

- 700 acres of corn
- 700 acres of soybeans
- 300 acres of small grain
- 100 acres of alfalfa

Direct weed control tactics

Cultivation tools
After planting but before emergence, Scott likes to "blind harrow" with an Einbock Tined Weeder. This can be done fairly quickly (4-6 mph). After crop emergence and before the crop is large enough to cultivate, they will either rotary hoe or fine weed the crop: the hoe is fast but not as thorough as the Einbock, which operates at only 2 mph. Their first cultivation is done with a Danish Tine style cultivator, which has 5 shanks per row. The shanks next to the row are points (not shovels), allowing them to run very closely to the row and not throw dirt over the crop.

Scott's farm also has a cultivator (3 shanks per row with standard shovels) with tunnel shields for small crops. Additionally, there are 2 rolling cultivators (Lilliston style), one set to pull dirt away from the row and one set to roll dirt into the row. They also have a couple of cultivators set for medium sized crops (3-5 mph) and a couple of single-sweep cultivators for "lay by" or final cultivation (run at a maximum speed of 6-8 mph). Scott believes that having lots of tools with different purposes allows them to fine-tune each one for a specific purpose. Once a cultivator is set for a specific task, there is not a lot of adjustment needed later; they can just pick the cultivator for the job, hook it up, and go.

Scott's farm has 4 tractors that can run in the crop, and at times all 4 are in use. Two of these are set up with RTK guidance. They plant with the guidance to make the rows straighter, which in turn makes the cultivating easier and allows them to set the equipment more tightly. Cultivating with the guidance is not completely automatic, but it lets them run faster and look behind more without doing as much damage to the crop. Scott also highly recommends a hydraulic third link on a tractor. This makes changing cultivator depth, rotary hoe, and tined weeder pressure adjustments much easier so they can be done more frequently and on the go.

Experience with flame weeding
Scott has a 16-row flamer that they initially used only as a rescue tool but now use a lot more. It is a must-have tool for them, but at the same time Scott feels that the crop can be set back as much as the weeds, especially when flaming small crops.

Experience with organic herbicides
Scott has no experience with organic herbicides.

Interview continued on next page