Controlling Weeds and Building Soil Health During the Three Year Transition to Organic

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The three year transitional period from conventional to organic row cropping can be the most challenging time for an organic farmer. Maintaining or improving weed control and soil health is never more vital than during this time, but it is also the period in which a new organic farmer is likely to have the least experience with organic practices. In this experiment we examine seven transitional cropping systems to gain information on best management practices for weed control and soil building during the transition into organic row cropping. The overall goal of this research project is to improve the competitiveness of transitional organic grain crop producers by documenting critical information on cropping systems that will help maintain or increase productivity, suppress weeds and build soil health.

Project Objective

In Missouri, many farmers transition into organic production by stopping chemical herbicide and fertilizer use while increasing tillage. Increased tillage has been implicated in soil degradation and erosion and is of major concern in a state with 12.9 tonnes of topsoil loss per hectare per year. In organic row cropping, reduced tillage must be accompanied by increased ground cover to reduce weeds. Organic no-till has been found to be successful in some areas of the U.S. and can improve soil carbon retention, water holding capacity and soil structure. In this experiment we compare organic no-till to conventional tillage and modified tillage/cover crop production systems.

Table 1. Seven Rotational Strategies

		Rotational System						
Year		Cover crop only (CCO)	Modified Cover Crop (MCC)	No-Till Corn-Soybean (NTCS)	No-Till Sorghum-Soybean (NTSS)	Conventional Corn-Soybean (CONVCS)	Conventional Sorghum-Soybean (CONVSS)	Modified Conventional (MC)
2012	winter crop	mix of hairy vetch, winter rye, austrian pea, oats, tillage radish, crimson clover						
	tillage	minimal till	minimal till	none	none	as needed	as needed	minimal till
	summer crop	sorghum-sudangrass	sorghum-sudangrass hay	soybean	soybean	soybean	soybean	sorghum-sudangrass
2013	winter crop	mix of hairy vetch, winter rye, austrian pea, oats, tillage radish, crimson clover						wheat
	tillage	minimal till	minimal till	none	none	as needed	as needed	as needed
	summer crop	sorghum-sudangrass	sorghum-sudangrass hay	corn	grain sorghum	corn	grain sorghum	soybean
2014	winter crop	mix of hairy vetch, winter rye, austrian pea, oats, tillage radish, crimson clover		wheat				cover crop mix
	tillage	minimal till	minimal till	none	none	as needed	as needed	as needed
	summer crop	sunn hemp	corn	soybean	soybean	soybean	soybean	corn

Rationale for each rotation

Cover crop only: This rotation uses the transition years as a time for intense soil building and weed control. Sorghum-sudangrass increases organic matter build-up and is an excellent weed smother crop. The terminal rotation crop is high nitrogen-fixing Sunn hemp, providing N for the next year's cash crop. The other six treatments are being compared to this system as a strategy for maximum soil building and weed control vs. practices that provide a cash crop during the transition years. *Cover crop modified:* This system provides two years of good soil building and weed control before a cash corn crop. The sorghum-sudangrass is mowed once during the season to force greater root development, which produces more soil organic matter than aboveground vegetation. A corn cash crop is grown the third year. *No-till:* Uses covers crops with a soybean/corn/wheat rotation, which is a typical grain crop rotation once organic certification is achieved. No-till reduces the carbon footprint of organic farmers by using cover crops flattened and killed by a roller/crimper as a weed blocking mulch instead of relying on multiple tillage for weed control. *Conventional:* This is the most widely used organic grain crop system in Missouri and includes a soybean/corn/wheat rotation with cover crops exploited for nitrogen, weed control and soil building. Tillage prior to planting and during the growing season follows conventional practices and is used as needed to control weeds. *Sorghum-soybean rotations:* Both no-till and conventional rotations are replicated using grain sorghum as the 2nd year cash crop rather than corn. Grain sorghum has a history of success in MO, has better weed control and yields more organic matter than corn. *Modified conventional:* This transition begins with one year of soil building and weed suppression, using a winter cover crop mix and sorghum-sudangrass in the summer. This is followed by winter wheat and soybeans in year two and the cover crop mix and corn in year three, with tillage as needed to control weeds

Sorghum-sudangrass makes an excellent summer cover crop because it provides significant weed control. It can be mowed and hayed throughout the summer., which improves weed control and increases root growth. The plot on the left was mowed once during the growing season.

Results

Extreme drought in 2012 had major effects on the germination and growth of plots in this experiment. This research was done in a field that was in pasture until recently and was probably more similar to crop ground coming out of CRP than crop ground coming out of traditional non-organic row cropping. Perennial weeds were common in this field as were annual grasses. Perennial weeds are not killed using a roller/crimper and many of the annual grasses emerged after the crops had been planted and were not controllable in no-till plots. The no-till rotations had severely depressed yields due to weed pressure. The drought was less severe in 2013 due to heavy spring rains, but extreme dryness still had a large impact on yields. The wheat plots in the modified conventional tillage treatment averaged 1809 kg/ha and were fairly heavily infested with curly dock, a perennial weed. Corn was planted at a density of 86,000 seeds/ha. Germination was low in both the conventional and no-till plots and yield was lower in the no-till plots than in the conventional till plots. Corn in the no-till plots was visibly yellower, indicating that the cover crop breakdown could be tying up nitrogen. The no-till plots had about 900 more kg/ha of weed biomass than the conventional tilled corn plots and yielded 1745 kg/ha less. Grain sorghum yields were severely affected in the no-till plots with the rolled cover crop. Germination was reduced and it appeared that the small grain sorghum plants had difficulty emerging through the thick cover crop mat. Because of slow early growth of grain sorghum in the conventional tilled plots, row cultivation was delayed, which allowed early weed growth that adversely impacted grain sorghum yields

Table 2. 2012 Results

Transitional system	2012 crop	Crop Height (cm)	plants/ ha	Weed dry matter (kg/ha)	Crop dry matter (kg/ha)	Soybean grain yield (kg/ha)
cover crop only	sorghum-sudangrass	165a		5872b	5477a	
modified cover crop	Sorghum-sudangrass	128b		6585a	1868c	
modified conv till	sorghum-sudangrass	137b		5652b	3530b	
conv till corn/soy	soybean	86c	208,014c	3733e	2906c	3010c
conv till sorghum/soy	soybean	81c	154,217d	5210c	2791c	2955c
no-till corn/soy	soybean	50d	143,458d	4153d	768d	396d
no-till sorghum/soy	soybean	49d	142,500d	5244c	935d	381d

data in each column with the same letter is not statistically different

Table 3. 2013 Results

Transitional system	2012 crop	2013 crop	Plants/ha	Weed dry matter (kg/ha)	Cover crop dry matter (kg/ha)	Sorg-Sud biomass yield (kg/ha)	Corn grain yield (kg/ha)	Sorghum grain yield (kg/ha)	Wheat grain yield (kg/ha)
cover crop only	sorghum-sudangrass	sorghum-sudangrass		93 b	5477 b	46,350			
modified cover crop	sorghum-sudangrass	sorghum	159,201 a	2552 a	4605 b			1247 a	
modified conv till	sorghum-sudangrass	wheat							1869
		double crop soybean	137,688 a	234 b					
conv till corn/soy	soybean	corn	51,632 b	2574 a	6148 b		4857 a		
conv till sorghum/soy	soybean	sorghum	116,174 a	3122 a	7919 a			844 b	
no-till corn/soy	soybean	corn	55,935 b	3520 a	9757 a		3112 b		
no-till sorghum/soy	soybean	sorghum	73,146 b	3504 a	7020 ab			245 c	

data in each column with the same letter is not statistically different

Conclusions

The winter cover crop used in this study was a polyculture of cereal rye, Austrian winter pea, hairy vetch, spring oats and crimson clover. Using diverse cover crops creates greater biodiversity of plant residues that fuel soil microorganisms. These soil microbes are vital for transforming organic soil nutrients into forms that can be taken up by growing plants. Planting into thick cover crop mulch can be challenging and may have caused decreased crop germination in this study. If a cover crop is to be disked in, it should be mowed first to prevent crop germination problems from interference with heavy residues. When using a roller/crimper, crop germination may be improved by planting into the standing cover crop, then rolling. However, this may cause the rolled cover crop to provide less than adequate weed control. Producers using organic no-till should experiment with small areas of both methods.

Sorghum-sudangrass has proven itself excellent at weed control, especially when mowed during the growing season. Mowing eliminates broadleaf weeds and causes greater underground root growth. This root growth will contribute to improved soil health by adding to the active soil carbon pool. Active carbon is freshly decomposed plant residue that fuels soil microorganisms and the mineralization of organic nutrients to plant-usable inorganic forms. After very bad crop growth in the first year of this study, we were afraid that the entire plot area would need to be abandoned from increased weed pressure. However, in plots where sorghum-sudangrass was grown, weed control improved and after the three year transition may be well suited for improved crop productivity.

After two years of using organic no-till in multiple experiments we are seeing that the cover crop mat does not hold back weed germination all season and that ways to deal with weed control must be researched before organic producers can be expected to adopt no-till practices. In this study, we are beginning to use between-row mowing in no-till plots, which achieves about the same level of weed control as cultivation in tilled plots. Organic farmers using no-till must be prepared to make changes to their plans as each growing season progresses. For example, if winter cover crop biomass is not high enough to provide a dense residue mat, a producer may need to revert to tillage that year to control weeds. Our experience shows that farmers wishing to use no-till organic should start with small areas to protect against economic loss from reduced yields.

Organic no-till requires careful management to be successful and we do not encourage its use during the three year transition to organic. Producers must focus on reducing the weed seed bank during that time. Using high residue crops and cover crops during the transition will not only reduce weed pressure but will also build soil health by increasing soil organic matter. Because tillage causes the release and loss of soil organic carbon stores, it should be used only when needed for weed control. Although tillage controls growing weeds, it also promotes the new germination of weed seeds. Mowing is a better method of eliminating weeds and reducing the weed seed bank.

Minimizing tillage while increasing plant residue should be a focus during the three years of transition from conventional to organic management practices. An excellent way to accomplish this is to transition small areas at a time and to plant continuous cover crops throughout the transition. If the weed seed bank can be reduced and soil health improved, the loss of revenue from this practice may pay off in improved soil productivity and weed control once the land has completed the three year transition.

This plot of no-till corn yielded well because the winter cover crop at this site produced enough biomass (9520 kg/ha) to create a thick, weed blocking mat.
The majority of the no-till plots did not do well due to inadequate cover crop biomass (6272 kg/ha) and inadequate weed control. In areas where cover crop biomass was adequate, mid and late season weeds often emerged and became yield reducing.

This field of no-till soybean was planted in the first year of transition from conventional to organic. Herbicides had reduced the weed seed bank after many years of usage, so this field was relatively weed free in year one of the transition until about mid-season, when annual waterhemp came up through the cover crop mat. The cover crop biomass before planting was 6898 lbs/acre and bare ground can be seen in this photo.
In year two, there was significant weed pressure in this field.

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