

Environmentally Friendly Vegetable Systems: Evaluating Cover Crops, Compost and the Combination - 2005 SWMREC Research

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Summary

A 6-year study of vegetable systems and soil quality improvement in a sandy soil was implemented in 2001 at 2 locations in Michigan, at the Montcalm Research Farm near Entrican, MI, and at the Southwest Michigan Research Extension Center near Benton Harbor, MI. The crops tested include potatoes grown in rotation with snap beans, sweet corn or wheat with or without one of 3 different cover crops. The three potato-snapbean rotation systems are also split for a poultry compost soil amendment comparison. Objectives of the experiment are to evaluate sustainability, in terms of environmental impact, profitability and biological resilience in the face of a highly variable climate. We are monitoring yield, horticultural product quality, soil nutrient efficiency and quality characteristics over time, and in soil quality over time.

Four years of results are providing strong evidence that the use of poultry compost/dried manure in combination with a winter cover crop is a technology that produces consistently higher crop yields, at lower levels of fertilizer (Figure 2). By contrast, crop yield after a bare winter fallow is declining, and soil is becoming degraded. In three of the four years (2002, 2003 and 2005) winter cover crop treatments were associated with increased yields (10 to 18%). Red clover was the most beneficial cover crop, improving soil quality parameters and vegetable yields. An important exception was 2004, where all cover crop treatments tended to be associated with yield reductions compared to a bare winter fallow. This may be related to a cold, wet spring which could have reduced nitrogen availability from organic sources at a critical point in time. Over the long-term we are testing if this immobilization of nitrogen in cold springs can be minimized by enhancing soil biology. This could explain why organic farming tends to be more successful after three years of transition time. Our research in 2006 will provide insights into practices that minimize transition problems and improve nutrient synchrony with crop demand.

Our findings are being translated into practical tools farmers can use to improve management of organic nutrient sources. This will help both organic farmers and farmers who are integrating fertilizers with organic amendments. This last is a growing number of farms: over one-third of Michigan potato and vegetable farmers are now experimenting with incorporating manure and cover crops on a larger scale. In our research, manure application did not affect incidence of common scab but we recommend vigilance against any potential disease issues and the use of resistant varieties. The long-term nature of our trial provides insights into the benefits of a three year rotation compared to a two year. Potato tuber yields, sweet corn yields and disease levels were lowest in three-year rotation sequences compared to any of the two-year potato rotations tested.

Methods

Field Experiments: A 6-year trial was initiated in 2001 at the Montcalm Research Farm (MRF) in Entrican, MI and at the Southwest Michigan Research and Extension Center (SWMREC) near Benton Harbor, MI. Both sites have well-drained, loamy sand to sandy loam soils that are

common soil types used to produce a wide range of vegetable crops in Michigan. At MRF, the soil is a Montcalm/McBride loamy sand and at SWMREC the soil is an Oakville series fine sand transition to loamy sand (Table 1.). The two sites provide information about performance under a vegetable and potato production environment at a southern Michigan location with a warmer spring, and a cooler central Michigan location.

Table 1. Soil texture and chemical properties for 0-8” depth at the Montcalm Research Farm plot

Organic C, %	Average	1.5
	Range	0.4 – 3.6
Texture, % sand	Average	78
	Range	63 - 89
Calcium, ppm	Average	388
	Range	200 - 1000

The trial includes seven 2-year potato rotations and one 3-year rotation system with 3 cover crop options (see Table 2).

Table 2. Rotation, cover crop and compost treatments used in long-term potato rotation experiment at Montcalm Research Farm and SWMREC

	Rotation	Cover Crop	Manure
1.	2Y Potato / Snap Bean	Bare (no cover crop)	+ or - manure
2.	2Y Potato / Snap Bean	Rye	+ or - manure
3.	2Y Potato / Snap Bean	Rye + Hairy Vetch	+ or - manure
4.	2Y Potato / Corn	Rye after Potatoes, Bare after Corn	
5.	2Y Potato / Corn	Rye + Hairy Vetch	
6.	2Y Potato / Wheat	Wheat after Potatoes, Rye after Wheat	
7.	2Y Potato / Wheat	Wheat + Red Clover (frost seeded clover)	
8.	3Y Potato / Corn / Wheat	Rye+Hairy Vetch or Wheat+Clover	

Rotation treatment 1 represents a worst-case system where soil is left bare after potato harvest. Treatment 8 is included as a best-case option with a 3 year rotation using less tillage and cereal+legume cover crops. Rotation treatments 2 and 4 represent commonly used rotations and winter cover crops for Michigan potato growers.

Three snap bean rotation treatments were split for a poultry manure treatment comparison. Dry, partially composted poultry manure is applied annually to split plots at 2.5 T / acre in the spring before planting. Principle crops and cover crops were planted with standard commercial equipment. Varieties and hybrids used are listed in Table 3. Fertilizer was applied to potato plots at the recommended rate of 180 lb N/acre. Reduced amounts of N fertilizers were applied to manure- and cover crop-treated plots. 50 lbs. N/acre was credited for manure application, 10 lbs. N/acre was credited for a rye cover crop, and 30 lbs. N/acre was credited for a rye+vetch cover crop. Plots were irrigated as needed. Cover crops were planted after principle

crops were harvested in the fall except for red clover which was frost-seeded into wheat in the spring. Standard pest and weed control measures were used throughout the growing season.

Table 3. Varieties of cash crops and cover crops used in long-term rotation experiment at SWMREC

Crop	Variety or Hybrid
Potato	Snowden
Snap Bean	HiStyle
Sweet Corn	Jackpot
Wheat	Caledonia
Rye	Wheeler
Hairy Vetch	Common
Red Clover	Mammoth

Results

Soil nitrogen supply capacity has increased in treatments with added organic amendments, as shown in Table 4 below.

Table 4. The influence of cover crop systems and manure on soil characteristics at SWMREC

Winter Cover crop		NO ₃ (0-20cm)		NO ₃ (20-50cm)		30d NMP (0-20cm)	
		Mean (mg/g dry soil)	SD	Mean (mg/g dry soil)	SD	Mean (mg/g dry soil/d)	SD
Bare	- Manure	7.24	2.81	3.54	0.50	0.13	0.05
	+ Manure	7.59	1.89	3.40	0.61	0.21	0.04
Rye	- Manure	7.28	2.13	4.16	1.20	0.20	0.04
	+ Manure	7.16	1.25	3.99	1.03	0.23	0.15
Rye+Vetch	- Manure	6.40	2.54	3.54	0.51	0.25	0.08
	+ Manure	9.30	3.71	4.31	1.23	0.23	0.05
Clover	- Manure	7.57	1.55	3.51	0.83	0.30	0.11

Table 5. Average total potato tuber yields in 2004 for long-term potato/vegetable soil quality experiment at Montcalm Research Farm and SWMREC.

System	US#1 Yield	B Yield	% Scab
S bean – bare – potato	238	21	31
S bean – rye - potato	205	13	49
S corn – rye - potato	197	20	42
Wheat – rye - potato	228	21	55
Wheat/red clv - potato	187	17	41
S bean – MIX - potato	178	16	43
S corn – MIX - potato	204	16	38
Three year rotation	236	15	17
P-value	0.04	0.13	0.005

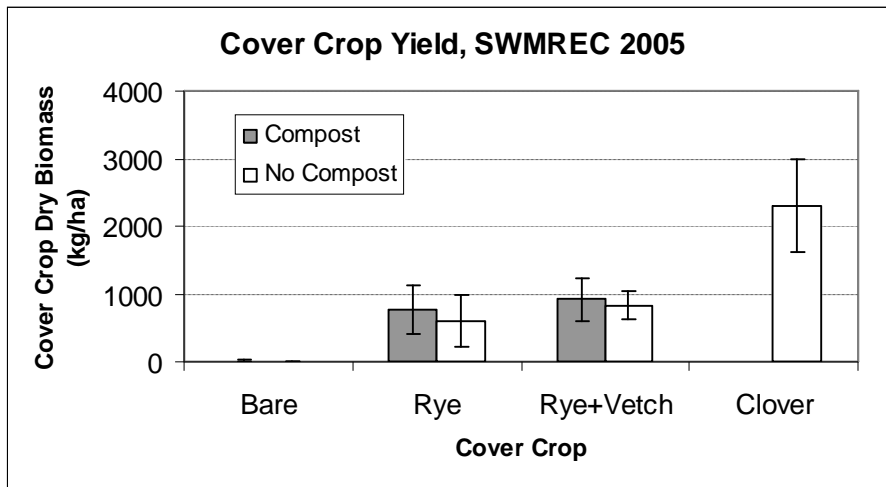


Figure 1. Cover crop biomass yield (kg/ha) by cover crop treatment and location

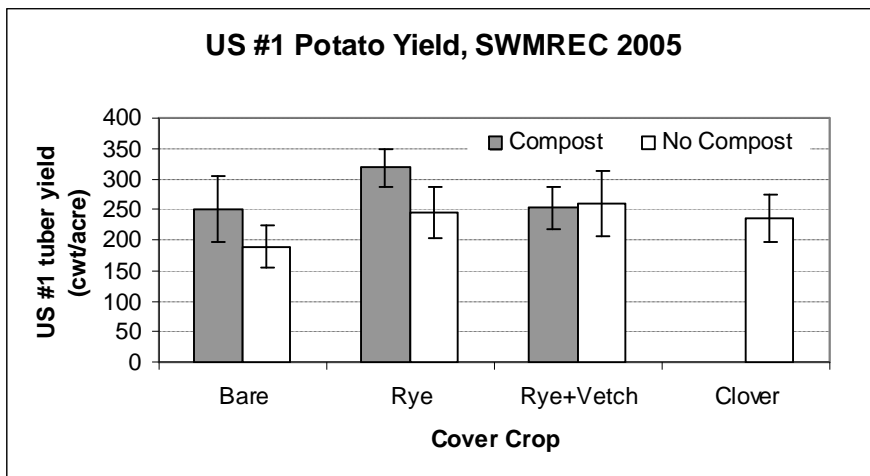


Figure 2. US No. 1 tuber yield (cwt/acre) at SWMREC in 2005 by poultry compost and cover crop treatment from long-term soil quality rotation trial.