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Horticulture Research

Quick Turnaround Cover Crops for Horticulture -- Update 2014

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Cooperators:
- **Rob and Tammy Faux – Tripoli**
- **Rick and Stacy Hartmann – Minburn**
- **Nicholas Leete and Alice McGary – Ames**
- **Mark Quee – West Branch**

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In a Nutshell

- Fruit and Vegetable farmers use cover crops to improve nutrient cycling and control weeds for increased production efficiency.
- Summer cover crops can be challenge due to dry conditions.
- Four farms evaluated summer cover crops to determine aboveground biomass production, carbon and nitrogen produced, effects on subsequent cash crop germination and effects on subsequent weed seed germination.

Key findings:

- Summer-seeded cover crops produced between 192 and 14,157 lb of biomass per acre across the farms. Species selection, location and days of cover crop growth tended to dictate biomass production.
- Not surprisingly, legume species contained more N than non-legumes, though buckwheat also tended to contain a large amount of N.

Project timeline:
June 2013 to October 2013
June 2014 to September 2014

Cow peas, buckwheat, oats-peas and sorghum-sudangrass at Scattergood Friends Farm.

About the Cooperators

Rob and Tammy Faux own and operate Genuine Faux Farm near Tripoli. They grow vegetables and herbs, as well as turkeys, chickens and ducks. They focus on marketing their produce directly to clients, and sell their products mainly through Community Supported Agriculture (CSA). They also sell at Waverly Farmers' Market when they have extra produce available. Their farm has been certified organic through IDALS (Iowa Department of Agriculture and Land Stewardship) since 2007.

Since 2004, **Rick and Stacy Hartmann** have taken an old farmstead of about 10 acres near Minburn and turned it into a vibrant business growing specialty horticultural crops. They focus on working directly with families and individuals mostly through their Community Supported Agriculture (CSA) to market their produce raised on IDALS-certified land. They always strive to incorporate practices that are environmentally sustainable, including their efforts to conserve and restore the farm landscape to support native and wild pollinators.

Mustard Seed Community Farm near Ames is a diversified vegetable farm with a mission of healthy food accessible to everyone. Members of the farm grow vegetables and herbs to supply their CSA and food donations. They incorporate farming practices such as cover crops, permaculture, perennial crops, beneficial insects and animal habitats as they try to create a farming system that closely mimics nature.

Mark Quee manages Scattergood Farm, at a small Quaker boarding school near West Branch in Cedar County, with 10 acres of IDALS-certified organic gardens and orchards and 30 acres of pastures used for grass-finished beef and lamb. Scattergood also raises a few heritage breed Guinea hogs, a small flock of turkeys, occasional broiler flocks, and a laying flock of about 100 chickens. Scattergood primarily grows food for their school, but occasionally sells to outside markets.

Background

Crop rotations in fruit and vegetable systems are complex. Farmers strive to rotate crop families to curtail disease as well as crops with high and low nutrient needs to maintain healthy soil fertility. Cover crops can play an important role in fruit and vegetable systems and bring a number of benefits such as reducing weed populations, adding organic matter and enhancing nitrogen cycling in the soil, and reducing erosion (Creamer, 1999). The window between spring and fall plantings would benefit from all these cover crop attributes. However, with a busy and intensive schedule for vegetable producers during the limited growing season, incorporating cover crops while maximizing the amount of vegetable production can be a challenge (Sundermeier, 2009). Therefore, choosing the most appropriate cover crop species according to the climate and the desired purpose is crucial. The goal of this project was to examine potential cover crop species and evaluate their abilities to grow adequately during the summer to add diversity to a crop rotation, build soil, and suppress weeds in a short timeframe in Iowa's climate. Due to weather conditions in 2013 (cold and wet spring followed by summer drought) some cooperators for this project had to replant their cover crops for this trial. Each cooperator's trial is described separately. They are explained under Methods and Results section. All the biomass samples are taken to Iowa State Soil and Plant Analysis Laboratory for dry matter weight, and total carbon and total nitrogen analyses.

Table 1

Genuine Faux Farm in 2013.

	Millet	Buck-wheat	Field pea	Clover
Planting date	August 21, 2013			
Planting method	Broadcast			
Termination date	October 2, 2013			
Days of Growth	42			
Aboveground biomass (lb/ac)	1,686	1,722	2,044	1,401
Total Carbon (%)	35.6	41.2	41.6	36.9
Total Nitrogen (%)	2.1	2.3	3.6	3.7
C:N	17.0	17.8	11.7	9.9
C content (lb/ac)	600	709	851	517
N content (lb/ac)	35	40	73	52

Table 2

Small Potatoes Farm in 2013.

	Sunn hemp	Legume mix
Previous cover crop	Chickling vetch	
Planting date	June 28, 2013	
Planting rate (lb/ac)	112	47
Planting Method	Broadcast, then disked	Drill
Termination Date	August 20, 2013	
Termination Method	Mow, then tillage	
Days of Growth	53	
Aboveground biomass (lb/ac)	4,677	14,157
Total Carbon (%)	39.8	37.4
Total Nitrogen (%)	3.9	3.6
C:N	10.3	10.5
C content (lb/ac)	1,859	5,298
N content (lb/ac)	181	506
Subsequent cover crop	Hairy vetch + cereal rye	
Weed seed germination (No./ft^2)	49	32

Methods and Results

Genuine Faux Farm

The Fauxes planted four cover crops, two reps of each. Each plot size was 50 feet by 20 feet. Since the first planting of cover crops did not germinate due to the lack of rain, they replanted the cover crops which resulted in later planting date (August 21). The Fauxes did not evaluate the subsequent cash crop following cover crop termination. There were little differences among the species in terms of aboveground biomass production or carbon concentration (**Table 1**). As expected for legume species, clover and field pea had greater nitrogen concentrations than did buckwheat and millet.

Small Potatoes Farm

The Hartmanns planted two cover crop varieties – Sunn hemp and a legume mix – each in one field (0.143 ac and 0.160 ac respectively). They chose high seeding rates because they like to have a think stand, as their goals for planting cover crops are weed control and biomass production. The legume mix produced more biomass than the Sunn hemp, despite a lower seeding rate, and had slightly lower carbon and nitrogen concentrations, though these may not be statistically significant (**Table 2**). Weed counts were slightly lower and the following crop germination counts (hairy vetch and winter rye) were slightly higher in the legume mix as well.

Mustard Seed Community Farm

At Mustard Seed, four cover crops were planted in three replications. Individual plot size was approximately 100 ft long and 15 ft wide. Some cover crops were planted

Statistical Analysis

When possible data were analyzed using JMP Pro 10 (SAS Institute, Inc., Cary, NC) and comparisons among measured variables employ least squares means for accuracy. Least significant differences statistical significance is reported at the $P \leq 0.05$ level with tendencies noted at the $0.05 < P \leq 0.10$ level and means separations are reported using Tukey's Least Significant Difference (LSD).

Table 3

Mustard Seed Community Farm								
	Sunn hemp		Millet		Cowpea		Buckwheat	
Previous cover crop	Oats							
Planting rate (lb/ac)	46	60	40	53	69	90	92	120
Planting date	July 20, 2013							
Termination date	September 13, 2013							
Days of Growth	55							
Aboveground biomass (lb/ac)	1,156		369		192		553	
Total Carbon (%)	40.8		42.2		41.4		40.2	
Total Nitrogen (%)	3.1		3.1		3.4		3.3	
C:N	13.2		13.6		12.3		12.2	
C content (lb/ac)	472		156		79		223	
N content (lb/ac)	36		11		6		18	

at 115% of the recommended drill rate into harvested oats and then lightly tilled; others were seeded at 150% of the recommended rate into standing oats, which were then scythed to provide cover (**Table 3**). They delayed their planting date due to the lack of soil moisture and forecast rain. No weed or subsequent crop counts were taken, as they did not plant a subsequent crop. They decided not to plant any fall crop because soil moisture and rainfall were limiting. They determined it would not be an efficient use of water and labor resources to start new crops. There were no statistically significant differences among species for biomass production or nitrogen concentration. Total carbon was lower in buckwheat compared to the other species.

Scattergood Friends School

2013

At Scattergood, three reps of six cover crop varieties were planted. Each plot size was 50 ft by 20 ft. Statistical analysis could not be conducted on the biomass or nutrient content of the cover crops, but it seems that sorghum-sudangrass produced the most biomass and cowpeas the least; chickling vetch had the greatest nitrogen concentration and millet the least; and buckwheat had the greatest carbon concentration and cowpeas the least (**Table 4**). Spinach was sown on September 16 in the same field following summer cover crops. However, spinach had yet to germinate on October 2, when they took weed and cash crop germination counts. Weed counts were analyzed across species and reps; there were no differences among species but the reps differed vastly, anywhere from 7 to 22 plants per square foot.

Scattergood Friends School

2014

In 2014 at Scattergood Farm three replications of four different cover crops were planted (**Table 5**). Cover crops evaluated were Sunn hemp, buckwheat, oats/field

Table 4

Scattergood Friends School -- 2013						
	Sunn hemp	Millet	Cowpeas	Sorghum sudangrass	Buck-wheat	Chickling vetch
Previous cover crop	Hairy vetch					
Planting rate (lb/ac)	60	20	90	30	120	80
Planting date	July 1, 2013					
Planting method	Drill					
Termination date	August 12, 2013					
Termination method	Mow, then tillage					
Days of growth	41					
Aboveground biomass (lb/ac)	5,335	5,776	3,262	12,569	5,920	3,061
Total Carbon (%)	40.7	39.5	38.6	39.5	42.1	39.7
Total Nitrogen (%)	2.7	1.3	3.5	1.4	3.8	4.0
C:N	38.0	30.6	11.1	38.1	11.1	10.0
C content (lb/ac)	2,173	2,280	1,260	4,970	2,489	1,214
N content (lb/ac)	145	74	113	177	224	122
Subsequent Crop	Spinach					
Weed seed germination (No./ft^2)	8	13	10	11	18	15

Table 5

Scattergood Friends School -- 2014					
	Buckwheat	Millet	Sunn hemp	Oats/Pea	LSD
Previous cover crop	Hairy vetch + winter-killed oat				
Planting date	July 9, 2014				
Planting method	Drill				
Termination date	September 17, 2014				
Previous crop	Hairy vetch/winter killed oat				
Days of growth	71				
Aboveground biomass (g/ft^2)	55.7	50.0	37.7	27.3	39.2
Aboveground biomass (lb/ac)	5,341	4,797	3,614	2,622	
Total Carbon (%)	40.5	41.1	41.1	38.4	
Total Nitrogen (%)	2.54	2.10	2.72	3.21	
C:N	15.9	19.6	15.1	11.9	
C content (lb/ac)	2,163	1,972	1,485	1,007	
N content (lb/ac)	134	101	98	84	
Subsequent crop	Spinach				
Spinach germination rate (%)	17.0	18.0	34.3	30.3	37.7

pea mix, and pearl millet. All were purchased from Green Cover Seed in Bladen, Nebraska. "While we had tested Japanese millet in the past, we picked pearl millet instead for the trial this year, as it was recommended because it grows taller and longer before entering the reproductive stage. Also Japanese millet is best for very wet, waterlogged conditions. With the weather we had in Iowa this summer Japanese millet might have worked quite well, but treatments were selected in the early spring prior to abnormally high summer rainfall," states Cooperator Mark Quee.

Each plot size was 20 ft x 100 ft. They were planted on July 9 in the field following a robust hairy vetch and winter-killed oat cover crop. One, one-foot square quadrat of aboveground cover crop biomass was sampled from each plot on August 25. Weight, total carbon and total nitrogen of the aboveground biomass were measured by the Soil and Plant Analysis Lab at Iowa State University. Cover crops were rototilled on September 3 and 17. Cover crops finally died after the second rototill pass. 100 spinach seeds were sown in each plot on September 18 following all the summer cover crops. Cash crop germination counts were taken on October 9. Due to cool, dry temperatures at cash crop planting the seeds were irrigated about 2 weeks after planting because field conditions were dry. Weed counts during spinach emergence were not taken because little weed pressure was present.

The aboveground biomass among the cover crop treatments (**Table 5**) was not statistically different (P = 0.3623). Carbon to nitrogen (C:N) ratios varied among the cover crops. As expected the C:N ratio of pearl millet, a warm season grass was the greatest at 19.6. The C:N ratio of buckwheat and Sunn hemp, both warm season broadleaves, were similar at 15.9 and 15.1, respectively. Sunn hemp is a nitrogen-fixing legume and could explain why its C:N was slightly lower than buckwheat. The oat and pea mix C:N was the lowest 11.9 which would provide for the best nitrogen cycling potential for the following cash crop of the cover crops evaluated.

Spinach germination (**Table 5**) was not affected by the previous cover crops (P = 0.1561) but germination was less than 50%. Prior to planting the spinach, plots were rototilled twice to terminate the cover crop. Following this almost two weeks passed until spinach was planted and conditions became very dry. Scattergood then irrigated the plots and seeds germinated. The most seeds germinated following the Sunn hemp treatment, 34%, then the oats and pea mix, 30%. Spinach following the millet and buckwheat treatments was 18% and 17%, respectively. None of the germination rates were statistically different.

Conclusions and Next Steps

Growing cover crops in the summer months provides an opportunity to not only protect soil but also build its ability to cycle nutrients, compete with weeds and improve future crop yields. But to choose the right cover crop, evaluation of its effect on a following crop and its overall biomass production is important. Because the variables of this trial vary greatly among the cooperators, it is not possible to make general conclusions. However, according to the feedback we collected from our participants, those who included millet and buckwheat in their trial expressed that these two species seem to be the solid choices of summer cover crops. Mark Quee noticed that the buckwheat cover crop germinated and grew quicker than the other cover crops, which resulted in improved initial weed management. Additionally, Mark commented that use of a field cultivator to prepare the cover crop seedbeds initiated weed germination. "I regret that we used a field cultivator instead of the rototiller to prepare the cover crop seedbed." More cover crops including those in mixes need to be evaluated to determine if they are an appropriate summer cover crop for farmers in Iowa.

Among the cover crops varieties tested for this trial, Sunn hemp is not a common option in the Midwest. Originated in India, Sunn hemp is usually known as tropical or sub-tropical cover crops (USDA, 1999). However, there was an increasing interest in testing Sunn hemp among Practical Farmers horticulture cooperators at last Cooperators' Meeting in February 2013, because of its said ability to provide nitrogen. At all the farms which tested Sunn hemp for this trial, it germinated well and provided biomass. Moreover, two of the farms, Small Potatoes Farm and Mustard Seed Community Farm, noticed that their Sunn hemp plants started to flower. Rick Hartmann at Small Potatoes Farm suggested exploring the possibility of breeding Sunn hemp seeds in Iowa. Currently, Sunn hemp seeds are costly and it is said the area where Sunn hemp can be grown for seed is very limited, mostly in Southern Texas (USDA, 1999). It might be worthwhile to consider examining the seed cultivation of Sunn hemp in Iowa as a future cover crop study.

Depending on a following cash crop assessing the C:N ratio of the cover crop will be important. For example a buckwheat cover crop with a C:N ratio of 15.9 is similar to manure. That cover crop prior to a heavy nitrogen feeding cash crop would be a good fit. On the other hand the C:N of sorghum-sudangrass in 2013 was 38.1. This cover crop provides good forage material and carbon additions to re-building soil but should only be followed by a low nitrogen cash crop user unless significant amounts of nitrogen fertility is added.

Finally, those who tested cowpeas in the trial expressed they did not have good experiences with them. Nicholas Leete and Alice McGary from Mustard Seed Community Farm commented that they have tried cowpeas a number of times so far, and whether it was a dry or wet summer, cowpeas have not yet performed well for them. Next steps for this trial would be to measure weed control during initial cover crop germination compared to a control plot.

References

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PFI Cooperators' Program

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