Project Title: Identification of superior cover crop varieties for organic seed production in the Maritime Northwest

Principal Investigator:
John Navazio
Research and Education Specialist
Washington State Univ./Organic Seed Alliance
PO Box 772
Port Townsend, WA 98368
360.385.7192
navazio@wsu.edu

1. Project Summary

In recent years demand for cover crop seed has grown parallel with the increase in organic and sustainable farming. Increased demand combined with increased distribution costs are resulting in price increases and seed shortages, particularly for organic seed. Organic producers are also required to use organic seed sources if available, but often must rely on conventional seed or pay high prices for shipping organic cover crop seed. This project helps secure organic farmers' access to organic cover crop seed by increasing knowledge and success of on-farm cover crop seed production. Through cover crop variety trials focused on seed production qualities we delivered researched-based information for producers, researchers and agricultural professionals who utilized this information and continued building on this work.

We conducted evaluations of 5 cover crop species, testing 4 to 6 varieties of each, to determine which varieties will both successfully mature seed in season and produce acceptable yields of high quality seed in the Maritime Northwest. All accessions were evaluated for their ability to 1) produce a vigorous, strong cover to protect the soil and discourage weed growth, 2) produce a superior mature seed set in a timely fashion at the end of the season, and 3) produce a superior seed harvest of viable seed.

We will host a field day at the time of seed harvest to demonstrate and discuss the trial evaluation process, cover crop production methodology, seed production principles and practices, on-farm genetic selection to maintain superior seed stock, and harvest and seed cleaning methodology. We will also produce a research bulletin that includes a report of trial results, a description of the value of on-farm organic cover crop seed production, and basic cover crop seed production guidelines.

This project represents important first steps towards the creation of a regional organic cover crop seed production system.

2. Introduction to Topic

Provide an introduction to the organic farming issues being addressed by this project and what led to the development of this project.

Cover crops are a cornerstone of organic farming practices. They assist with soil fertility, weed management, pest management, erosion prevention, and run-off prevention (SAN, 2007). Cover crop seed is increasingly in demand as the number of organic farms and the price of fertilizer increases. In fact, higher demand combined with increasing distribution costs is resulting in concerns of cover crop seed shortages. For organic producers, lack of access to cover crop seed is a serious production risk.

OSA's long term goal is to increase quality, quantity and affordability of organic cover crop seed by: a) supporting producers in learning to produce cover crop seed, b) supporting the creation of improved, regionally adapted cover crop seed, and c) supporting the creation of regional cover crop seed production systems. This project takes an important first step towards this long-term goal by simply learning which varieties of the most popular cover crop species will produce marketable quantities of seed in the Maritime Northwest region. It also begins the work of educating new cover crop seed growers and inspiring additional research efforts through a publication and field day. For organic producers, access to the information generated by this project will minimize farm production risks by facilitating successful on-farm organic cover crop seed production.

Due to the increase in value and demand for cover crop seed, regional, direct market and contracted cover crop seed production now represents a significant market opportunity for organic producers. This project is important to organic producers because it will assist them in enhancing their profitability by providing information on the production of cover crop seed as a farm diversification and cost-saving strategy.
Our project is also important to organic producers because it aims to increase the quality, quantity, and diversity of organic cover crop seed available, thus assisting producers to come into compliance with National Organic Program rules for use of organic seed.

3. Objectives Statement

Our primary objective was to determine which cover crops are capable of producing good yields of high quality, organically grown seed in a Maritime Northwest climate.
Through field evaluation of 4 to 6 varieties in each of 5 cover crop species we produced first year results on which crop species and which available varieties within the species are capable of maturing a competitive yielding, quality seed crop in the Maritime Northwest. The measurable outcome for this objective is the results of this trial. Accomplishing this objective will be the first step to growing cover crops in the quantities necessary to sustain a regional organic cover crop seed production and distribution system. We will use these results as groundwork for future research and hope to inspire similar efforts in additional regions.

Our secondary objective was to disseminate trial results and cover crop seed production information to producers.
We will accomplish this objective in two ways. First, we will host a field day at the research site. At the field day we intend to share the variety field evaluation results and demonstrate the specific skills necessary for producing organically grown cover crop seed. We will distribute questionnaires at the end of the workshop to gather information from farmers on the effectiveness of our teaching and the usefulness of the specific information taught at the workshop. Second, we will publish a research bulletin that will include trial results along with an introduction to the value of on-farm cover crop seed production and basic guidelines

for seed production practices of the project focus crops. The bulletin will be distributed through the OSA, WSU and eOrganic websites.
Measurable outcomes for this objective include: 1) attendance of at least 30 producers and other agricultural professionals at the field day, 2) positive feedback on field day evaluation forms, and 3) at least 200 copies of the research bulletin downloaded through the eOrganic and OSA websites. Accomplishing this objective will help farmers secure organic seed for on-farm use and/or gain an economic return from a crop that additionally builds farm soil quality, assists in weed management, and enhances farm ecology.

~~4.~~ Materials and Methods

Describe your project methodologies and materials used. Where were the trials conducted and what was the certification status of these sites? How were treatments applied? What data were collected and how? What statistical analyses were conducted? Maps or drawings of the site and/or any special apparatus used are very helpful (hand drawings are fine). Provide as much detail as possible in this section.

Trial location and design: The cover crop seed production suitability trial was conducted during the growing season of 2010. The trial site was at Nash's Organic Produce in Sequim, WA, using Nash's standard management practices and representing a real-world production setting. Sequim provides an ideal trial site, with a climate that will allow trial results to be relevant to growers from coastal northern California to coastal southern British Columbia (the Maritime Northwest). The experiment was conducted as several randomized complete block designs (RCBDs), one for each species, with three replications per RCBD. Experimental entries included varieties within species. Each plot was10 feet long by 4 feet wide, with 2 foot alleys between plots.

Materials: We consulted with farmers, researchers, and seed industry professionals to prioritize the following five cover crop species for evaluation: buckwheat (*Fagopyrum esculentum*), oats (*Avena sativa*), hairy vetch (*Vicia villosa*), red clover (*Trifolium pretense*), and field peas (*Pisum sativum*). With advice from the cooperating host farmer and input from seed companies and plant breeders we selected four to eight varieties from each of the five species to evaluate.

General Methods: All plots were planted with a grain drill at the recommended seeding rate.

Analysis: Means for traits of species and varieties were compared based on an Analysis of Variance (ANOVA) and Fisher-protected least significant differences (LSD) with a p-value of .05. Means and significant differences are reported in the tables.

5. Project Results

Present your project results. Quantitative results (numerical and/or statistical data) and qualitative results (descriptions of how well or poorly something worked) are both important. Tables, graphs, photos, and other figures representing your data are excellent ways to summarize data and present them in an accessible way.

Vetch Methods and Results: 8 varieties of vetch were planted in September 2010 and evaluated April, 5th, 2011. The trial was established in three replications of 12 ft x 8 ft plots. Varieties included 3 sources of Common Vetch (variety not stated) from Albert Lea Seed House (AL), Johnny's Selected Seeds and Kaup Seed; 2 varieties from Groff Seed, Groff Early Riser 1 and Groff Early Riser 3; 2 USDA releases produced by Allied Seeds, Purple Bounty, and Purple Prosperity. Varieties varied significantly in rate of spring growth after overwintering. This is important for establishing a good ground cover and competing with weeds. Growth rate was evaluated on a scale of 1-9 with 9 being the highest amount of growth. The lower growth rates were due to the variety unsuccessfully overwintering. Common vetch from Albert Lea Seeds had a significantly higher growth rate than all other varieties followed by Groff Early Riser 1 and 3 and Purple Bounty, which were significantly higher in overwintered growth rate than the other four varieties. Growth rate was the only data collected from the crop because weed competition and mixing of varieties in the field made harvest of individual plots too difficult for the producer. The farmer cooperator reports that the ability to overwinter and grow rapidly in the spring is the most critical quality in vetch varieties so this limited data was still very useful in selecting varieties for future seed production.

Buckwheat Methods and Results: 6 varieties of buckwheat were planted May 26, 2011 in 2ft by 10 ft plots. Varieties included 5 un-named varieties (populations) of common Buckwheat from High Mowing Seed, Johhny's Selected Seeds, Territorial Seeds, Hearne Seeds, and Albert Lea Seed Company. The 6th variety was a variety called 'Mancan' from Peaceful Valley. Plots were evaluated for emergence, timing of flowering, leaf health, maturity, stature, and fresh weight. All traits were evaluated qualitatively on a scale of 1-9 with 9 being the most desirable quality and 1 being the least desirable of the quality trait. Varieties varied significantly in emergence with Buckwheat from Territorial and High Mowing Seeds, and Mancan from Peaceful Valley having a higher emergence rate than varieties from Hearn, Johnny's, and Albert Lea. At crop maturity, seed set, all plots were evaluated for stature and a 2ft x 2ft area was harvested and weighed for fresh weight as an indicator of relative biomass. Stature was rated as 9 for upright and 1 for prostrate growth pattern. The variety from Territorial was more upright than Hearne, Johnny's, or Albert Lea. There were no significant differences in fresh weights at harvest. Varieties were rated for rate of maturity at the time of full flowering and no significant differences were found.

Red Clover Methods and Results: 8 varieties of red clover were planted May 26th, 2011in plots 4ft wide by 12ft long including 4 from Albert Lea (Marathon, Medium Red, Freedom and Arlington); 6 from Allied Seed (Marathon, Kenland, Cinnamon Plus Southern Belle, FSG961 and FP345); and 1 from Kaup (Medium Red). Plots were bordered by a planting of FSG961. The clover trial was evaluated for relative levels of ground cover on a 1-9 scale with 9 being the highest ground cover. Weeds overtook the trial and it was plowed under in the early spring prior to collection of additional data.

Pea Methods and Results: 8 varieties of peas were established fall of 2010 in plots 4ft wide and 12ft long from the USDA (Windham, Isard, Dove HR, PS03101269, Granger, Specter, Frostmaster, and Melrose). Plots overwintered and were evaluated the following

spring. Growth rate was rated on April 11, 2014 on a scale of 1-9 with 9 = highest growth rate. Granger and PS03101269 were significantly higher in growth than Specter, Windham, Frostmaster, Dove HR, or Isard. Pod maturity was rated on June 5th on a scale of 1-9 with 9 indicating the most mature. Isard and Dove HR were significantly highest in maturity, followed by Winham and Frostmaster, and Granger, PS03101269, Specter, and Melrose ranked the least mature. 2ft by 2ft samples were harvested on September 13th, and threshed and cleaned for seed. Seed samples were weighed and Melrose and Granger were significantly higher in weight than Windham.

Oat Methods and Results: 9 varieties of oats were established May 25th, 2011 including 2 varieties from the Wisconsin Foundation Seed Program (Kame and Esker); 2 varieties from the Washington State Crop Improvement Association (Monida and Park); 4 varieties from Albert Lea (Buff, Tack, Colt, and Reeves), and 1 from Johnny's Seeds (Rodeo). Plots were evaluated for emergence on June 6th with Monida significantly higher in emergence than all varieties except for Kame and Park and Buff lowest in emergence compared with all other varieties. Plots were evaluated for weed cover on X with no significant differences found. Plots were evaluated for flowering on July 13th. Colt, Buff, Kame, and Reves were earlier in flowering time than Tack or Monida. Plots were rated for maturity and stature on September 6th with Monida significantly later in maturity than all varieties except for Park and Rodeo. No significant differences in stature were found.

Data Results:

Table A. Buckwheat

Variety & Source	Maturity Rating	LSD Group	Stature Rating	LSD Group	Fresh Weight (g)
Buckwheat - Albert Lea Seed	8.33	A	7.33	A	509.00
Buckwheat - Johnny's Seeds	7.00	B	6.67	AB	578.33
Common Buckwheat	6.33	BC	5.33	ABC	409.00
Buckwheat - Hearne Seeds	5.67	CD	4.67	BC	419.0
Mancan	5.33	DE	4.67	BC	479.67
Buckwheat – Terratorial Seeds	4.67	E	4.33	C	470.33
LSD	0.98		2.13		NSD

Table B. Red Clover

Variety- Source	Ground Cover Rating	Group
Medium Red - Albert Lea Seed	5.67	A

Freedom	5.33	AB
Kenland	5.00	AB
Southern Belle	3.00	ABC
Marathon	2.83	BC
Medium Red - Kaup	1.67	C
Arlington	1.67	C
Cinnamon Plus	1.67	C
LSD	3.16	

Table C. Oats

Variety- Source	Emergence Rating	Group	Weed Cover	Flowering Time Rating	Group	Maturity Time Rating	Group	Stature
Buff- Albert Lea	1.33	D	73.33	5.00	AB	6.67	A	5.33
Colt- Albert Lea	6.33	BC	56.67	5.33	A	6.42	A	5.55
Esker- WI	4.67	C	66.67	1.33	BC	5.67	A	5.00
Kame- WI	8.00	AB	50.00	5.00	AB	7.00	A	5.67
Monida- WA	8.67	A	51.67	3.80		2.68		5.00
Park- WA	2.33	D	65.00	1.00	C	3.00	B	6.67
Reeves- Albert Lea	6.33	BC	63.33	3.67	ABC	4.67	AB	7.33
Rodeo- Johnny's Seeds	4.67	C	66.67	5.00	AB	6.67	A	5.67
Tack- Albert Lea	5.67	C	65.00	1.33	BC	4.67	AB	6.33
				1.00	C	7.00	A	
LSD	2.15		NSD					NSD

Tale D. Peas

Variety- Source	Growth Rate Rating	Group	Pod Maturity Rating	Group	Seed Weight (g)	Group
Granger- USDA	6.33	A	9.12	A	4547.16	A
PS03101269- USDA	5.33	AB	8.68	A	4269.00	A
Melrose- USDA	3.00	ABC	6.33	B	2478.33	AB
Specter	2.33	BC	5.67	B	2289.00	AB
Windham- USDA	1.33	C	2.33	C	2169.33	AB

Frostmaster- USDA	1.33	C	2.33	C	1454.67	B
Dove HR- USDA	0.99	C	2.33	C		
Isard- USDA	0.96	C	1.00	C		
LSD	4.35		2.35		2443.64	

Vetch

Variety- Source	Growth Rate Rating	Group
VNS - Albert Lea	8.33	A
Groff Early Riser 1– Groff	5.00	B
Groff Early Riser 3- Groff	4.33	BC
Purple Bounty- Allied	4.33	BC
Purple Prosperity- Allied	3.00	CD
VNS - JSS	2.33	DE
Groff Early Riser 2- Groff	1.00	E
VNS - Kaup	1.00	E
LSD	1.64	

* LSD = Least Significant Difference
* NSD = No Significant Difference

6. Conclusions and Discussion

Discuss the results of the project and what you found out. What do the results lead you to believe happened, or did not happen? In the end, how useful was this project to you and the farm operation? How useful do you feel the study and results will be to other organic farms? Did you encounter any problems during the project? What would you do differently if you did this project again? Based on what you've learned, what do you think should be studied next?

This project resulted in practical benefit to the cooperating grower in several of the crop categories and the farm currently saves seed on all crops species evaluated. The ultimate goal of the cooperating farmer was to identify the best agronomic performing varieties that can also be successfully grown for seed in the mild, maritime climate of Sequim, WA. This goal was achieved in all, but the clover crop as it had to be tilled in early due to poor crop establishment. The trial did identify several significant differences in variety performance, however the trial presents only a single year of data. The researchers recommend additional trials across years to refine selection of optimum varieties for the region and consideration of additional quality traits, such as biomass, nitrogen fixation rates, and other traits associated with the benefits of cover cropping. An additional consideration is the potential performance of a variety grown as a mix compared to alone. The vetch for example in this trial was planted alone in order to focus on the performance of the variety, but it is customarily grown in combination with a grain such as rye. The vetch trial was tilled in prior to harvest due to excessive weed competition and poor crop

establishment. This would likely not have been the case if planted with a companion grain species. Following are conclusions by crop based on the available data from the single year of trials.

Buckwheat, Table A: The most important traits for buckwheat seed production are reliable maturity under the mild maritime conditions of the maritime NW. The cooperating farmer saved his own seed for many years until he had crop failure and had to source new seed. The new population had a much longer maturity timing and did not fully mature in his climate. This experience was in part the impetus for this project. This experience points to the variability of populations of a cover crop that are commonly marketed under the same generic name. Plant biomass and seed yield are also important for buckwheat, but biomass did not differ significantly among varieties while the timing of maturity did differ significantly. The grower conducted buckwheat trials of accessions from the NPGRS with Kevin Murphy, WSU, the same year in replicated trials conducted side by side with this trial. He saved seed from individual plots of the all of the varieties that were early maturing in each trial and visually had the highest seed quality (size) and estimated yield. The grower bulked this composite population and used it as planting stock to continue growing and selecting his own population. He is still saving seed of this composite population, now in the F4 generation in 2014. He has also selected the variety for earlier maturation and larger seed simply by timing his harvest early and setting his combine and seed cleaning equipment to eliminate smaller seed.

Clover, Table B: Weed competitiveness is critical in red clover as it can be a slow crop to establish. Weed competition was significant and the plots had to be tilled under due to poor plot establishment and weed competition. The relative level of ground cover was evaluated prior to incorporation and significant differences were found. These results suggest considering dropping the varieties slower to establish and re-evaluating the well-established varieties again.

Oats, Table C: Oat varieties differed significantly in emergence, but not in weed cover. As expected, there appears to be a trend in higher levels of weed coverage in varieties with low emergence. Clearly early and good emergence is important in minimizing weed competition and the potential for weed seed contamination in harvest. There were greater significant differences in the timing of flower than in the timing of maturity suggesting that flowering is not a good indicator of final maturity dates. The only significant maturity differences were in the later maturing varieites, Monida and Park. They were later than all varieties except for Reves and Tack. Timing of maturity is not extremely critical as harvest is normally in mid August when the weather is still dry and warm. The cooperating grower currently uses a blend of Otanna and Powell varieties, neither of which was in the trial.

Field Peas, Table D: Granger and USDA PS03101269 were the fastest maturing and highest yielding varieties of peas. They were significantly higher yielding than Frostmaster, Dove and Isard. Dove and Isard were the slowest maturing and did not yield in time for harvest. Timing of maturity is important in the ultimate yield and feasibility of

producing field peas as a cover crop in the region. The cooperating producer currently grows two varieties of field pea, one yellow and one green, reliably and uses them for human and animal feed, but he has lost track of the variety name.

Vetch Table E: The vetch trial was grown as single vetch varieties as treatments, however the cooperating grower normally produces vetch, even for seed production, mixed with annual rye. The vetch trial became very weedy as vetch alone is slow to establish ground cover and poor at competing with weeds. For this reason the vetch trial was tilled in prior to harvest. The trial was evaluated for growth rate prior to tilling under and varieties differed significantly. Growth rate is particularly important in the early spring when grown for the purpose of soil improvement as a cover crop, as opposed to a seed crop, as it is desirable to get early biomass in order to incorporate early and plant a successive crop in the spring. Based on this trait VNS from Albert Lea was significantly faster growing, followed by Early Riser 3 and Early Riser 1 from Groff, and Purple Bounty from Allied. It is interesting to note that three varieties from three different sources were generically named Vetch (VNS stands for variety not stated), and these three differed significantly in growth from the fastest to slowest growing in the trial. This demonstrates the need for variety trials to identify optimum stock seed when engaging in seed production.

7. Useful Tools, Information, and Resources for Farmers

This project reinforced the importance of selecting the best performing variety for the purpose of seed production as variety choice will affect yield, seed quality, and in some cases the ability to successfully mature and harvest a seed crop. The trial results are limited by several factors including the single year of data serving as a snapshot of performance under the conditions of that year; the limited number of variety entries; and the production methods which in some cases resulted in excessive weed competition and tilling in the trial prior to harvest. This project hopefully will serve to inform future cover crop seed trials and increase awareness of the importance of variety selection. The cooperating grower did benefit from the information in many of the crops and is currently producing seed of all crops. The grower benefited particularly from access to a new population of buckwheat that was created by mixing the best varieties. This new population reliably matures in his climate and is higher yielding than the population he was previously using.

8. Outreach

Describe the type of outreach that you conducted, or expect to conduct, including any publications, tours, or other presentations of your project to the public.

9. Financial accounting

2010 was a transition year for OSA with the handing off of the Executive Director position and implementation of a new accountant. OSA's accounting systems were less organized in 2010 and in prior years and a record of the project allocations is unclear. Financial records from 6/1/2010 through 12/31/2011 show $8,933.75 in staff salaries

allocated to the project and $351.32 on seed, stakes and field supplies. It is unclear how the funds for additional budgeted items were managed.

10. Leveraged resources

This project leveraged collaboration with Kevin Murphy, WSU, who was also conducting buckwheat trials in 2011. We coordinated seed sourcing and collaborated on trial evaluations in the field with Dr. Murphy.

11. References – N/A

12. Photos and other addenda

Please submit **photos** of your project site, of the results of different treatments, and/or of project cooperators and field demonstrations. Also include any additional materials, such as articles about the project, scientific articles, Extension bulletins, theses, or related research reports.