NORTHERN NEW YORK AGRICULTURAL DEVELOPMENT PROGRAM

Progress Report for Work Completed April 1, 2011 to March 31, 2012

NYSDAM CONTRACT # C200753

New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University
Ithaca, New York

The Northern New York Agricultural Development Program: Its Purpose and Background

In NYS, no area is more economically dependent on agriculture and more challenged in terms of the profitability and long term vitality of its farm businesses than the North Country. These challenges are exacerbated by factors that include, but are not limited to, the regions climatic constraints, its soil resources, and its distance from markets

In 2011-2012, the Northern New York Agricultural Development Program (NNYADP) continued to support agricultural research projects, demonstrations, and outreach in Jefferson, Lewis, St. Lawrence, Franklin, Clinton and Essex counties to help improve agricultural productivity and farm profitability. This report documents progress made on the projects that were conducted in the time period covering April 1, 2011-Marc 31, 2012. Ten projects are reported on to date, in the following areas:

- Agricultural environmental management
- Integrated pest management
- Biofuels/biomass production
- Field crop production and improvement
- Fruit and vegetable production

This document contains reports on all ten projects conducted under NYSDAM Contract #C200753 entitled: Northern New York Agricultural Development Programs.

The program is supported by funding from the NYS Senate though the long term sponsorship of the NYS senators that represent the 6-county Northern NY region, with support of NNY Assemblypersons and the Assembly Ag Committee. The program also receives support (funds, land, staff and expertise) from Cornell University's College of Agriculture and Life Sciences, the Cornell University Agricultural Experiment Station, the NYS Agricultural Experiment Station in Geneva, Cornell Cooperative Extension at Cornell and in each of the six NNY counties, the W.H. Miner Agricultural Institute, the U.S. Department of Agriculture, cooperating farmers and agri-service businesses.

For more information on the Northern NY Agricultural Development Program contact Jon Greenwood, Co-chair for WNNY, 315-386-3231; Joe Giroux, Co-chair for ENNY, 518-563-7523 or girofarm@together.net; Margaret Smith, Cornell University contact, 607-255-2552 or mes25@cornell.edu; or Dave Smith, Cornell University contact, 607-255-7286 or rds4@cornell.edu. Additional copies of this report are available from Margaret Smith.

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Brian Knight, St. Lawrence
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Maple and Forestry Products

Tony Corwin, Essex
Jeff Jenness, St. Lawrence
Jen Parker, Clinton
Kenneth Tupper, St. Lawrence
Dean Yancey, Lewis
Haskell Yancey, Lewis
Jeremy Youngmann, Clinton

2011-2012 Northern New York Agricultural Development Projects Funded

Project Title	Researcher(s)	Amount
Evaluating Soil Test Phosphorus Variation on NNY Farms Based on Colorimetric and ICP Determination Methods: A Preliminary Investigation	Eric Young	$ 11,370
Hands on Training for On-farm Application of Nematodes to Control Alfalfa Snout Beetle	Joe Lawrence	8,800
On-Farm Rearing of Biocontrol Nematodes for Alfalfa Snout Beetle: Improving Outreach Communications with Multimedia Approaches	Elson Shields	7,500
Grass Biomass Potential in NNY	Jerry Cherney	18,880
Optimizing Grass Biomass Yield and Quality for Combustion	Jerry Cherney	25,330
Breeding Alfalfa Varieties with Resistance to Alfalfa Snout Beetle	Don Viands	2,000
Soybean Trials in Northern NY	Bill Cox	2,600
Corn Hybrids for Grain Production in Northern New York	Margaret Smith	4,200
Managing Fertility to Increase Yields in Field Grown Vegetables	Amy Ivy	3,200
Management Strategies for Fall/Winter Greens Production in NNY	Mike Davis	8,600
NNYADP Project Management, Publicity	R. David Smith	25,200

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Evaluating soil test phosphorus variation on NNY farms based on colorimetric and ICP determination methods: A preliminary investigation

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Collaborator(s): Bruce Hoskins, University of Maine, Orono, ME
Eric Bever, Champlain Valley Agronomics, Peru, NY
Michael Contessa, Champlain Valley Agronomics, Peru, NY

Cooperating Producers: Soil samples from various farms in Clinton, Franklin and Essex Counties were taken as part of this project. The names of the cooperating producers will be kept confidential for this project.

Background: Phosphorus (P) is a critical nutrient that can limit crop productivity and its management is an important environmental consideration on dairy farms. Agronomic and environmental P guidelines in NY are based on P extracted by the Morgan solution (sodium acetate). Fertilizer recommendations for P in NY are based on measuring P in the Morgan extract using molybdate colorimetry (e.g., spectrophotometer), which estimates the inorganic orthophosphate concentration in solution (biologically available P). Most soil laboratories also use inductively coupled plasma spectroscopy (ICP) to determine P and other nutrient cations in soil extracts. ICP measures multiple elements simultaneously and represents the *total* amount of an element in solution due to the high temperature plasma environment. Thus, soil test P (STP) measured by ICP may include organic and inorganic P. Several studies have reported that STP determined by ICP is often greater than STP measured by colorimetry (Pierzynski et al., 2005). The additional P measured by ICP reflects organic and/or particulate P forms not measured by the colorimetric procedure (Pierzynski et al., 2005).

The practical implication of the additional P measured by ICP is that it represents a potentially important plant-available P source once mineralized by soil microbes. Current agronomic P recommendations in NY, and nearly all land grant universities, do not account for this P or any organic P. A better understanding of P dynamics is needed to develop testing procedures for improved prediction of P availability, and will ultimately help dairy farms maximize P use efficiency and reduce P losses. The objectives of this project were to determine the extent of STP variation between the ICP and the colorimetric method for a large number of NNY soils, and to identify soil test factors influencing STP differences between the two methods.

Methods: In the fall of 2011, 244 soil samples were collected from different agricultural fields in Clinton, Essex and Franklin counties. The objective was to sample a range of soil properties representative of NNY. Samples were collected during October and

November 2011 by Champlain Valley Agronomics, Peru, NY. Standard agronomic soil sampling methods were followed. Approximately 15 cores were taken from each field to a depth of 8 inches. Samples were mixed thoroughly immediately following core collection in the field and a composite sample was taken for analysis. All samples were sent to the University of Maine Soil Testing Laboratory for analysis.

All major and micronutrients were extracted in pH 4.8 sodium acetate (original Morgan) at a 1:5 (v:v) extraction ratio for 15 min. Phosphorus was determined colorimetrically and by ICP. All other nutrient cations were measured by ICP alone. Soil pH was measured in distilled water. Organic matter was determined by loss on ignition at 500 C (2 hr) after oven drying at 110 C to constant weight. All solution analyses were run on the original (undiluted) soil extracts. Scooped volumes were weighed and all results are presented on an oven-dried weight basis.

Differences between STP measured by ICP and colorimetry were compared using linear regression procedures in SAS (SAS, 1999). In addition, the numeric difference between STP measured by ICP and colorimetry was modeled using stepwise multiple linear regression. The dependent variable was the difference in STP between the two methods and pH, organic matter, and extractable nutrient cations (with the exception of P) were used as the set of independent variables. The probability to enter the model was set P= 0.05 and a value of P= 0.01 was used to as the threshold to remain in the model.

Results and Discusison: Samples spanned a wide range in pH, organic matter, extractable nutrients and soil test P (Table 1, Appendix). The samples collected also represent a wide range in soil types, drainage capacity, and texture.

Although STP measured by ICP and colorimetry were highly correlated across all samples (Fig. 1), STP measured by ICP (STP-ICP) was consistently greater than STP measured by colorimetry (STP-Color). STP-ICP concentrations were 2.5 lb/ac greater than STP-Color averaged across all samples (Table 1). The ratio of STP-ICP to STP-Color increased strongly at STP-Color values <20 lb/ac (Fig. 2), indicating that unreactive P in the Morgan extract (presumed to be mostly organic) was greater at lower STP concentrations. At low STP levels, STP-ICP was as much 3.5-fold greater than STP-Color (Fig. 2). The greater difference between STP-ICP and STP-Color is also observed when a lower range of STP values is used for to compare the relationship between methods. For example, when STP-ICP values of ≤ 10 lb/ac are regressed with corresponding STP-Color values, STP-ICP was approximately 29% greater than STP-Color as predicted by the slope of the regression line (Fig. 3a). For STP-ICP values of <15 lb/ac, predicted STP-ICP values were approximately 18% greater than STP-Color (Fig. 3b). These relationships highlight the fact that unreactive P concentrations were greater at lower STP levels. Whether or not this additional P is plant-available is an open question that needs to be addressed. For manure, NY guidelines assume that all P (e.g., organic + inorganic) contributes to crop uptake, even though some fraction of this is likely fixed by the soil before plants can utilize it. For soils, it is likely that some portion of the soluble organic P is mineralized during the season and would contribute to the plant-available P pool.

Multiple linear regression analysis showed that soil organic matter (SOM) and aluminum were important explanatory variables influencing the difference between the two methods. Aluminum and SOM were both positively correlated with the numeric increase in STP-ICP over STP-Color and together explained 53% of the variation. It is well known that organic acids and Al readily form complexes with P, which may partially explain the direct relationship between greater unreactive P in solution and greater Al. Manganese and pH were also selected as significant (P<0.001) predictors and explained another 4% of the variation (Table 2).

The use of ICP is standard instrumentation in most soil testing laboratories due to its ability to accurately measure multiple elements simultaneously. ICP measures the total amount of an element in an extract because the high temperature plasma environment releases organically bound elements. For elements that readily form bonds with carbon in soils such as P and sulfur (S), ICP measurements reflect the total quantity of the element (e.g., sum of organic and inorganic forms). In a recent NY study, Ketterings et al. (2011) suggested that measurement of sulfur in calcium chloride extracts with ICP showed the most promise as a soil test for S and was the most consistent detection method across soil types. Measurement of S by ICP also showed the greatest increase in soil test S per pound of S applied, which may be related to the fact that ICP measures both organic and inorganic S in solution.

Fertilizer P guidelines are based on STP-Color values in NY and most other land grant universities. Iowa State University is one of the only universities in the US that have developed STP calibrations based on both ICP and colorimetric determination methods (Mallarino, 2003). For example, the critical STP (based on Mehlich-3 extraction) level (e.g, where additional P is not expected to increase yield) for corn in Iowa based on the colorimetric test is ~20 mg/kg, whereas with ICP it is ~35 mg/kg.

Results from our study indicate that STP calibrations based on ICP for NNY soils would differ substantially from STP levels based on the colorimetric test. As a practical way to assess the relative agreement between the methods, NY STP categories were assigned to each sample and the percent agreement in categorizing STP status was calculated (Table 3). Not surprisingly, the poorest agreement occurred for the lower STP categories. For the "Low" STP category (using ICP-Color as the basis), there was only a 16% agreement between methods (Table 3). This means that ICP measurement classified 84% of the samples into the "Medium" STP category compared to the colorimetric test (e.g., classified as all "Low"). For STP levels classified as "Medium" by the colorimetric test, ICP measurement resulted in 43% of samples classified into the "High" STP category. Agreement dramatically improved to 99 and 100% for the "High" and "Very High" categories, respectfully. Thus, the interpretation of STP depends on which method is used. For example, there is a difference of 20 lb P_2O_5/acre recommended between the "Low" and "Medium" categories and the "Medium" and "High" categories, which is a difference of ~$5/acre in potential fertilizer P costs (assuming ~$0.60/lb P).

Conclusions/Outcomes/Impacts: Results from our study indicate that NNY agricultural soils may contain substantial organic P which may contribute to plant-available P. While our study did not directly measure organic P, results suggest that unreactive P in the Morgan extract was substantial in lower P testing soils. Results highlight the need to develop calibrations for NNY soils based on ICP and also indicate a need to further investigate the role of organic P in providing plant-available P. In addition, current NY P guidelines would benefit from further refinement based on accounting for differences in soil type, organic matter, and pH, all of which are known to affect P availability. Further research to develop and calibrate soil tests aimed at improving P availability, including organic P dynamics, is warranted. A better accounting of plant-available P has important economic and environmental implications for NNY farms.

Outreach: Project results will be presented at the 2012 American Society of Agronomy/Soil Science Society of America/Crop Science Society of America Conference. Other outlets for this work may include other agronomy meetings and extension publications such as the Miner Farm Report.

Next steps: The next steps for this research would be to set up a series of soil calibration experiments in the green house and in the field. By including multiple soil types varying in P fertility and soil properties, critical levels for both STP-ICP and STP-Color could be developed. In addition, laboratory incubations and field experiments should be developed to characterize organic P and the hydrolysis of organic P (e.g., conversion of organic P to orthophosphate). This work will ultimately lead to improved analytical methods for accounting for the mineralization of organic P in NNY soils.

Acknowledgments: We would like to thank the Northern New York Agricultural Development Program for funding this research.

Reports and/or articles: Results from this project have not been published elsewhere.

Person(s) to contact for more information: Eric Young, Miner Institute.

References

Mallarino, A.P. 2003. Field calibration for corn of the Mehlich-3 soil phosphorus test with colorimetric and inductively coupled plasma spectroscopy determination methods. Soil Sci. Soc. Am. J. 67:1928–1934.

Ketterings, Q.M., C. Miyamoto, R.R. Mathur, K. Dietzel, and S. Gami. 2011. A comparision of soil sulfur extraction methods. Soil Sci. Soc. Am. J. 75:1578-1583.

Pierzynski G.M., H. Zhang, A. Wolf, P.J.A. Kleinman, A. Mallarino, and D. Sullivan. 2005 Phosphorus determination in waters and extracts of soils and by-products: Inductively-coupled plasma spectrometry versus colorimetric procedures. SERA-17 Policy Workgroup Paper [Online]. http://www.sera17.ext.vt.edu/Documents/P_Analysis_Comparisons.pdf

Appendix

Table 1. Summary statistics for soil test variables and soil test P (STP) measured by ICP and colorimetric procedures.

Soil test variable	N	Mean	SD†	Minimum	Maximum
pH	244	6.3	0.5	4.4	7.6
Organic matter (%)	244	3.6	1.2	1.1	7.5
K (lb/ac)	244	148	98	44	695
Mg (lb/ac)	244	420	346	61	1960
Ca (lb/ac)	244	3319	2342	593	31108
Al (lb/ac)	244	81	110	5	709
Fe (lb/ac)	244	12	15	1.9	154
Mn (lb/ac)	243	14	6	3.3	44
Zn (lb/ac)	244	2	1.5	0.4	11.3
STP-ICP§ (lb/ac)	244	18	21	2.5	195
STP-Color‡ (lb/ac)	244	15	21	1.4	192
STP-ICP - STP-Color†† (lb/ac)	244	2.5	1.5	0	12.9
STP-ICP : STP-Color	244	1.4	0.4	0.92	3.44

† Standard deviation
§ Soil test P measured by ICP
‡ Soil test P measured by molybdate colorimetry
†† Numeric difference between STP measured by ICP and colorimetry

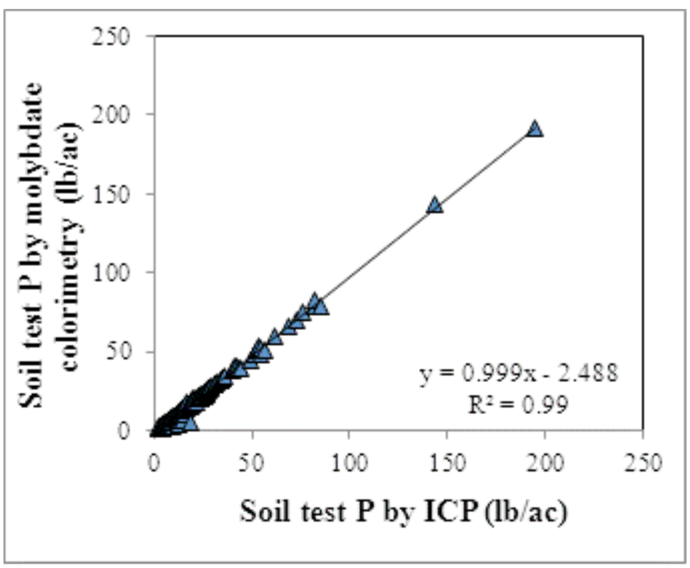

Figure 1. Relationship between STP-Color and STP-ICP and STP-Color for all samples (n = 244).

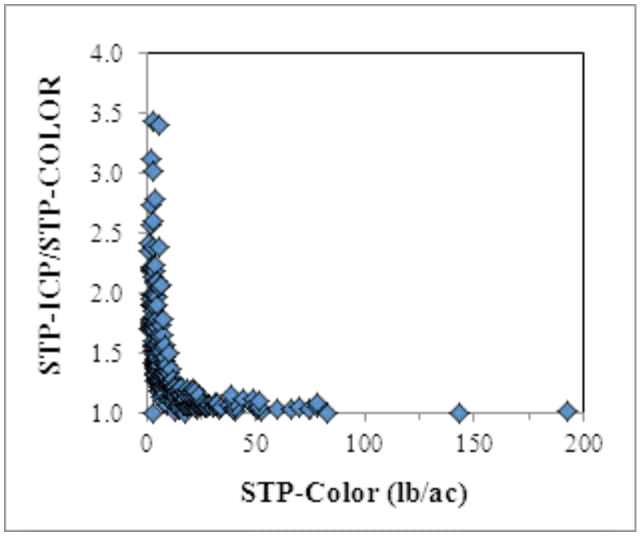

Figure 2. Relationship between STP-Color and STP-ICP for all samples.

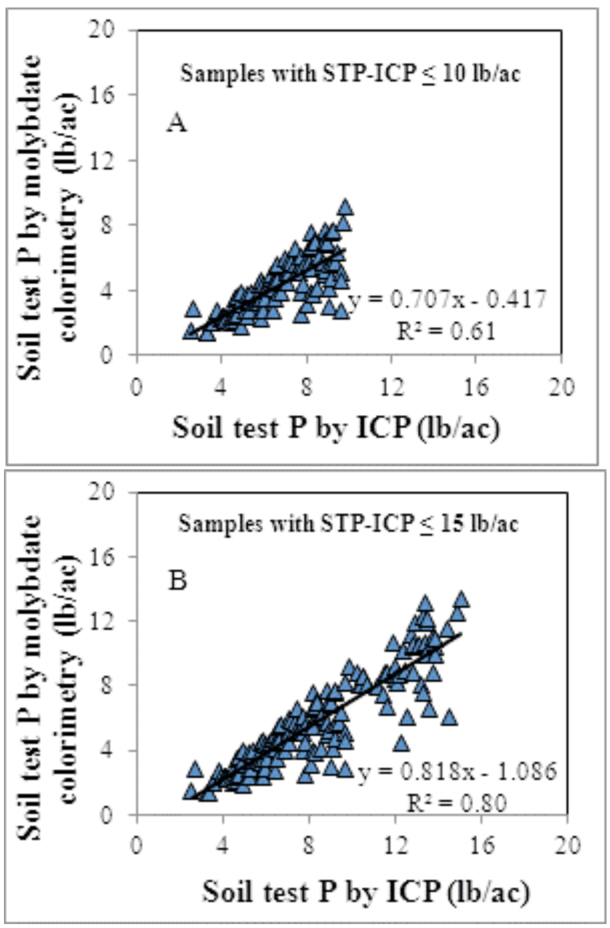

Figure 3. Relationship between STP-ICP and STP-Color for samples with an STP-ICP ≤ 10 lb/ac (A) and for samples with and STP-ICP level of ≤ 15 lb/ac (B).

Table 2. Summary of stepwise multiple linear regression statistics. The numeric difference between STP-ICP and STP-Color was used as the dependent variable and pH, organic matter, Al, Ca, Fe, K, Mg, Mn, and Zn were the set if independent variables.

Variable	Partial R-Square	Full model R-Square	F Value	*P*
Al	0.359	0.359	123.0	<.0001
Organic matter	0.170	0.529	29.1	<.0001
Mn	0.034	0.563	11.8	<.0001
pH	0.013	0.576	6.3	0.0067

Table 3. Percent agreement between ICP and colorimetric procedure for classifying samples into New York STP categories.

NY soil test P category	STP range (lb/ac)	% Agreement between ICP and Color methods
Very low	<1	-
Low	1-3	16
Medium	4-8	57
High	9-39	99
Very High	>40	100

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Hands on Training for On-farm Application of Nematodes to Control Alfalfa Snout Beetle

Project Leader(s):

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Cooperating Producers:

Alfalfa Snout Beetle Workshops 2012, Farmer Participants

Shelmidine, Doug	Jefferson	Fox , Jason	Franklin
Sullivan, Gary	Lewis	Martin , Clinton	Franklin
Sullivan, Kristy	Lewis	Ooms, Josh	Franklin
Mahoney, Jackie	Lewis	DeBeer, Mary	Franklin
Jones, Zach	Lewis	Choiniere, Real	Franklin
Greip, Jacob	Jefferson	Choiniere, Jean Louis	Franklin
Yousey, Nathan	Lewis	Mallette, Rod	Franklin
Schrag, Wilfred	Lewis	Dimock, Bruce	Clinton
Bonowski, Tom	Oswego	Beane, John	Franklin
Gohlert, Bernie	Lewis		

*Meeting was also attended by local agri-service professionals.

Background:

Alfalfa snout beetle remains the single most important limiting factor for alfalfa production in the NNY region where larval feeding kills out large portions of alfalfa stands each year. Long-term support from NNYADP has helped to identify biological control nematodes which have been demonstrated to be very effective in controlling alfalfa snout beetle in fields when applied. Since the nematodes are native to NNY, they persist in the fields after application for many years.

The Shields Lab, in cooperation with CCE and local farmers, have developed and fine tuned a very straight forward and low cost method for farmers to apply these nematodes to their own fields. To date, bio-control nematodes have been applied to 137 NNY alfalfa fields infested with alfalfa snout beetle. The current breakdown of nematode applied fields across the NNY 6 county region is: Lewis – 43 fields, St Lawrence – 39 fields, Jefferson – 25 fields, Franklin – 16 fields, Essex – 7 fields, Clinton – 7 fields. Since 2009, 24 farmers have self-applied nematodes to 48 of their own fields and the farmers reared the nematodes themselves for 20 of the 48 fields.

Farmers who have utilized this method have found the application technique to be very user friendly and several now have several years of experience rearing and applying nematodes on their own farms. We have also observed great collaboration between farms in sharing low cost, homemade nematode applicators (sprayers).

However, there are also a number of farmers who have been hesitant to implement this control. We believe that despite a highly visible educational presence on the topic at various meetings and through newsletter articles, etc. that many farms need to see the process in person to fully understand how it works before they are willing to try it.

Methods:
Three hands-on farmer workshops were organized across Northern NY. These workshops were held in Copenhagen (Lewis County) on March 6, 2012; Malone (Franklin County) on March 14, 2012 and Canton (St Lawrence County) on March 15, 2012.

The workshops were advertised through Cornell Cooperative Extension newsletters, websites and electronic communications. In addition a Press Release was issued to area media outlets and appeared in several publications and websites; including, Watertown Daily Times, Lowville Journal and Republican, Syracuse Post Standard, North Country Now, Jefferson County Journal, Farming Online, CCE News, Morning Ag Clips, Plattsburgh Press Republican and the NNY Gazette.

At each workshop farmers and agri-service professionals received hands-on instruction from Antonio Testa, Department of Entomology, Cornell and Dr. Julie Hanson, Department of Plant Breeding and Genetics, Cornell. The training included updates on research pertaining to both the biological control of Alfalfa Snout Beetle by Nematodes and the Plant Breeding effort to develop a variety of alfalfa with resistance to the damage done by Alfalfa Snout Beetle Larvae. The hands-on portion of the workshop allowed farmers to go through the process of growing their own nematodes and preparing them for field application.

As a result of attending a workshop each farmer received the supplies needed to for application of nematodes to a subset of fields on their farm in the summer of 2012.

Results:

Despite the extensive efforts to promote the workshops attendance varied across the three workshop locations. Total attendance was 23 for the three workshops representing an estimated 10,000 acres of cropland across Northern NY. In addition to farm attendants several agri-service professionals attended which will result in a greater dissemination of the information as they will be able to share the information with a larger number of their farm clients.

Conclusions/Outcomes/Impacts:

While we always strive for greater attendance this effort was successful in providing a means for farmers to receive hands-on training, equipping them to utilize this beneficial and environmentally friendly control measure for Alfalfa Snout Beetle on their farms.

Feedback from the workshops was very positives and farmers that attended said they were more comfortable with implementing the process on their farms as a result of attending. Directly through this project the farmers that attended are equipped to apply nematodes to approximately 1,200 acres of land in 2012. Indirectly, what they learned through the workshops will encourage them to apply this control method to all of their land as it is rotated into Alfalfa production in the coming years.

Successful use of these methods by the farms that attended will be utilized as an example for other farmers in their community to show this as an effective and economical means of reducing the impact of Alfalfa Snout Beetle on their farms leading to more acres being treated.

Outreach:

Cornell Cooperative Extension educators continue to promote the use of nematodes as a biological control for Alfalfa Snout Beetle to farmers through a variety of mechanisms, including farm visits, newsletter articles and demonstrations.

Additionally CCE educators continue to work with Cornell Staff to promote these methods including through the release of electronic communication resources such as the new Alfalfa Snout Beetle website which was developed with support from the Northern NY Agricultural Development Program.

Publicist Kara Dunn has done follow up interviews with a subset of the farmers who attended the workshops and a press release is being generated to publicize what was learned through the workshop and encourage other farmers to learn more about this as a control method for Alfalfa Snout Beetle on their own farms.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

Cooperative Extension Educators will be working closely with farmers who attended the workshops, providing technical support throughout the 2012 growing season to assure that they properly utilized the resources provided to them through the workshops to apply nematodes to their fields.

Cornell staff will monitor fields that will be inoculated in 2012 to assure that the nematode application are successful and persist in the fields to assure continued control of Alfalfa Snout Beetle.

Acknowledgments: We thank Northern New York Agricultural Development Program, Cornell Faculty and Staff, and Cornell Cooperative Extension educators for their collaboration and support.

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Photos

See individual report at:
http://www.nnyagdev.org/wp-content/uploads/2012/02/2011NNYADPReportASBNematode.pdf

Northern NY Agricultural Development Program
2011-2012 Project Report

Project Title:

On Farm Rearing of Biocontrol Nematodes for Alfalfa Snout Beetle: Improving outreach communications with multimedia approaches.

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Christopher Bogenschutz, Riverside Media Group

Cooperating Producers:

There are no producers to list for this project report. The following research activities were accomplished at Cornell University in our research facilities and did not require cooperation from outside producers;

1) Update all pertinent information about alfalfa snout beetle, damage, management with biological control nematodes, and rearing / application procedures for web publication.
2) Format all documents and pictures for web publication.
3) Create a Facebook page dedicated to alfalfa snout beetle, rearing and application of biological control nematodes.
4) Create and upload formatted documents to the NNYADP web master to be included in new alfalfa snout beetle web page.
5) Record “Nematode Rearing” instructional videos and upload to NNYADP web page, Facebook, and YouTube.

Background:

Alfalfa snout beetle remains the single most important limiting factor for alfalfa production in the NNY region where larval feeding kills out large portions of alfalfa stands each year. Long-term support from NNYADP has helped to identify biological control nematodes which have been demonstrated to be very effective in controlling alfalfa snout beetle in fields when applied. Since the nematodes are native to NNY, they persist in the fields after application for many years. To date, biocontrol nematodes have been applied to 137 NNY alfalfa fields infested with alfalfa snout beetle. The current breakdown of nematode applied fields across the NNY 6 county region is: Lewis – 43 fields, St Lawrence – 39 fields, Jefferson – 25 fields, Franklin – 16 fields, Essex – 7 fields, Clinton – 7 fields. Since 2009, farmers have self-applied nematodes to 48 of their own fields and the farmers reared the nematodes themselves for 20 of the 48 fields. Nematode treated areas of all fields have been recorded and those areas are visited annually to document nematode persistence for the duration of the alfalfa stand and nematode persistence across a corn rotation. This persistence database will allow estimates to be made about the necessity of reapplication of biocontrol nematodes to newly seeded alfalfa fields to prevent alfalfa snout beetle reinvasion.

In the initial 2009 pilot program effort funded by NYFVI to teach farmers to rear and apply their own nematodes, 10 farmers successfully participated. A second grant to expand the pilot program to a larger group of NNY farmers was funded by NYFVI in 2010-11 and then pulled back due to NYS financial problems before the program was initiated. Subsequently, funds were "borrowed" from other projects in the Shields' lab to assist 6 additional farmers with rearing and applying their own nematodes in 2010. In 2011, assistance was provided to 8 farmers from "borrowed" funds to continue the nematode rearing/application process across the North Country. In a continuing effort to expand the "Farmer Nematode Rearing and Application" program, a proposal was funded by Cornell Extension with monies available in the October 2011 – September 2014. These funds will partially support expanded efforts to work with NNY farmers and will be focused primarily on "hands on" instruction/assistance during the application season (April-October). This "Hands On" project would be greatly enhanced with a greater web presence, improved manual (electronic) and instructional videos and was the focus of this NNYADP proposal.

During the past six months our program has developed a Facebook page that allows individuals to have access to alfalfa snout beetle information, links to the various publications and videos on YouTube, while also updating visitors on recent activity by the program which include workshops and adult migrations.

The Shields' lab, with assistance from NNYADP and Riverside Media Group has developed a web page that will be located on the new NNYADP website. Visitors clicking on the Alfalfa Snout Beetle title will be taken to the snout beetle web page where all the pertinent information about the insect can be now found in one location. Instructional videos, rearing manuals, management tools, and the county maps showing treated areas, can all be found on the web page.

Methods & Results

Alfalfa Snout Beetle Project on Facebook

In December 2011, the Shields's lab developed a public page on Facebook dedicated to all information relating to the alfalfa snout beetle project. This page allows the farming community with internet access an easy way to keep current on information relating to the project. A public Facebook page allows the Shields' lab to post updates on adult emergence and movement, extension workshops, recent publications, biological control rearing techniques using nematodes, and upload links to training videos which are hosted on YouTube. Visitors can also find links to ASB documents, the ASB Rearing Manual, and the NNYADP website on the page. We encourage everyone to take a look.

Northern NY Agricultural Development Program Website

Beginning in January 2012, all current alfalfa snout beetle information including general information, management, biological control, publications, and the location of infested counties where ASB is a problem was updated and formatted into documents for uploading to a web page. With assistance from our student researcher and Riverside Media Group, we designed the site to allow visitors easy access to our information. Visitors are able to view an assortment of information on our page without having to leave the site. The alfalfa snout beetle web page can be found on the NNYADP website looking under Field Crop>Research>Crop Pests. Interested visitors can also go directly to our page by typing in http://www.alfalfasnoutbeetle.org/. The NNYADP website was re-launched in March 2012 to allow visitors easier access to the available information.

Nematode Rearing Videos

The Shields lab developed two instructional videos that were utilized in NNY Hands on Training for On-farm Application of Nematodes to Control Alfalfa Snout Beetle in March 2012. These two videos were the first in a series of instructional videos that will allow farmers the ability to view and understand the steps necessary in rearing biological control nematodes for field application against the alfalfa snout beetle located in their area. The first video focuses on the materials and supplies that a farmer should have on hand before starting the rearing process. The second video focuses on a step by step the process to initiate the nematode rearing process. These videos were developed using web cam technology and software purchased from TechSmith® called Camtasia Studio®. Live footage was recorded then edited to create the videos. The final videos for the instructional series will be completed during the summer of 2012 and will focus on washing the field cups, preparing the sprayer for application, and recording an actual application. A video camera was purchased using the funds allocated for this project to further develop and create these videos. These videos were uploaded to YouTube in March 2012 and can be found at:

http://www.youtube.com/watch?v=QNpNjFImrN0
http://www.youtube.com/watch?v=aD0eqbCfYAQ

Conclusions/Outcomes/Impacts:
The initial feedback from the NNY workshops in March was encouraging and positive. Workshop participates found the videos and the web page information very helpful. We expect the web page and Facebook page to show increased traffic once the 2012 growing season begins. CDs with the manual and videos will be made available on request to further assist farmers choosing to rear biocontrol nematodes.

We plan to follow up our educational efforts with a survey to better evaluate and improve our program. We will be adding a post-doc position to focus on these aspects the next 18 months and will have an intern during summer 2012 to interview and collect feedback to assist these goals.

Outreach:
2012 NNY workshops:
CCE – Jefferson and Lewis Counties – March 6, 2012
CCE – Franklin County – March 14, 2012
CCE – St. Lawrence County – March 15, 2012

Syracuse Post-Standard
http://blog.syracuse.com/farms/2012/03/programs_deal_with_nematodes_t.html

NNY Agricultural Development Program Website
http://www.nnyagdev.org/index.php
http://www.alfalfasnoutbeetle.org/

Alfalfa Snout Beetle Project on Facebook
https://www.facebook.com/#!/pages/Alfalfa-Snout-Beetle-Project/154247237964180

Next steps:
1) Evaluate the effectiveness of the multi-media educational tools currently developed and used in workshops.
2) Evaluate the effectiveness of the current on-going Extension educational program focused on teaching farmers to grow their own biocontrol entomopathogenic nematodes for alfalfa snout beetle control
3) Develop new video modules to complement existing modules.

Acknowledgments:
We thank Northern New York Agricultural Development Program and Cornell Cooperative Extension for their continuing support of our research and extension efforts.

Photos: See individual report under Multimedia Outreach at:
http://www.nnyagdev.org/index.php/field-crops/research-projects/research-alfalfa-snout-beetle/

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Grass Biomass Potential in NNY

Project Leader(s):
J.H. Cherney, Dept. of Crop & Soil Sciences, Cornell University

Collaborator(s):
Mike Hunter
Joe Lawrence
Rick LeVitre
Mike Davis
Quirine Ketterings

Cooperating Producers:
43 NNY farmers

Background:
New York and New England represent 80% of the nation's heating oil demand. In addition to global warming, northern NY has strong economic reasons for developing local bioenergy resources. A local closed-loop sustainable bioenergy source would greatly reduce imported liquid fossil fuels. New York State has an estimated 9 million tons/year of grass available for biomass, which is 75% of the total available grass biomass in the entire Northeast. Much of this potential grass biomass is in northern NY, with a significant underutilized land base capable of producing grass biomass.

Grass combustion bioenergy (bioheat) is several times more energy efficient than other bioenergy options, including grass conversion to ethanol. Grass combustion in the Northeast would reduce greenhouse gas emissions, help with nutrient management and energy costs on farms, generate rural jobs and economic diversification, improve soil health, maintain open spaces, and encourage species diversity and wildlife nesting.

From an environmental standpoint, global warming is caused by increased concentrations of greenhouse gases in the atmosphere, resulting from activities such as burning of fossil fuels. The Biomass Energy Resource Center in Vermont estimates that converting a residential gas or oil fossil fuel heating system to biomass would reduce net CO_2 emissions by 75-90%. REAP-Canada estimates that two acres of grass can meet the space and water heating needs of an average residence, and save from $700-$1000/year in heating costs over liquid fossil fuels.

Grass composition varies greatly due to fertility and harvest management, and biomass composition significantly affects combustion. There are currently only a select number of stoves and boilers capable of burning grass. Emissions are a function of the efficiency of the combustion device and the composition of the combustion fuel. Emissions from any type of combustion are coming under increased scrutiny from US-EPA and NY-DEC. NYSERDA is currently funding emissions testing, both at Cornell and at SUNY-Canton, on a range of stoves and boilers burning grass pellets. Emissions are a significant issue for biomass, whether it is burned on a small scale for residential heat, or on a larger light-industrial scale, such as heating schools or greenhouses. A number of minerals influence combustion and/or combustion emissions. The most important elements from an emissions standpoint are nitrogen, potassium, chlorine and sulfur. The gross energy content (BTU) and the total ash content also affect combustion efficiency.

One major concern when evaluating mineral composition of hay samples is soil contamination. A study in Wisconsin showed that hay samples had soil contamination resulting in Ash concentrations up to 18% of the dry weight of the hay. Soil contamination of hay is a function of soil type, relative smoothness/roughness of the soil surface, soil moisture, stubble height, number of equipment passes over the field, rainfall between mowing and baling, and length of time mown hay lays in the field. The type of hay-making equipment and how well it is adjusted will also influence soil contamination. From a combustion standpoint, it would be very useful to estimate the amount of soil contamination in hay bales.

Methods:

Hay produced by 43 farmers in the six county region was sampled between October and December, 2011. In general, hay lots were mulch-type hay, unsuitable for ruminant animal forage, although some of this hay may have been fed to beef cattle. Hay of reasonable forage quality is too valuable as a forage source, to be considered here.

10 bales from each lot of hay were sampled, most were large square bales, although round bales and small square bales were also sampled. There were a few lots of chopped hay, used for bedding, as well as three lots of baled corn stover. From 4 to 8 cores were taken from each bale. 102 lots of hay were sampled, generating 1,020 individual samples. Samples from each lot of hay were composited for compositional analysis. Samples were analyzed for CP, NDF, ADF, Lignin, Ash, Ca, P, Mg, K, S, B, Mn, Zn, Cu, Fe, Al, Na, Cl, Mo, and Ti by Dairyland Labs. Samples were analyzed for BTU content at Cornell University.

A set of representative soils were extracted with a plant extraction procedure, to determine the range in aluminum, iron and titanium extracted. This was necessary to determine if we can estimate the amount of soil contamination in hay, using elemental analysis of the hay. Plants do not contain much Al or Fe, and they contain no Ti, so that almost all of the Al, Fe, and Ti found in a plant analysis can be attributed to soil contamination.

Results:

As expected, bale lots were variable in composition. A major factor influencing composition was soil contamination. Although there was no visible soil found on the surface of bales when sampling, clearly it was present. Soil contamination is typically variable, and is a function of the soil type, soil moisture, harvesting equipment, and the length of time between mowing and baling.

Eleven lots of hay were selected and all individual bale samples were analyzed for ash and BTU (Fig. 1 & 2). Figure 1 shows that ash content is quite variable among bales with a 10-bale lot, although some lots are consistently low or high in ash. Figure 2 show the relationship between ash and BTU content of bales. The correlation is extremely high (r = 0.95), indicating that 91% of the variation in BTU content of these bales can be predicted just by knowing ash content. Figure 3 shows the relationship between lot means for ash and BTU.

Table 1 contains means and range in values for lots of hay for the important traits plus a few others. These data are all averages of 10 bales per lot. There was a 10-fold range in chloride content (Fig. 4) and some of these lots are not suitable for small scale (residential) combustion. There was also a considerable range in potassium and sulfur content (Fig. 5 & 6), but these concentrations would have much less impact on combustion, compared to the chlorine content. Nitrogen content is also variable (Fig. 7), but is also less of a problem compared to chlorine.

The Titanium content of hay samples was quite variable (Fig. 8), reflecting soil contamination. Plants do not take up any Titanium, so all Ti present is from soil on the plant. Essentially all of the hay lots have some soil contamination. There is a range in Titanium extracted from soils (Fig. 9), but it is not yet clear if Al, Fe, and/or Ti content of hay can be used to estimate soil contamination, when we know the soil type of the hay field. There is a strong relationship between Al/Fe/Ti and Ash content of hay. The correlations with Ash were Al = 0.86, Fe = 0.90, and Ti = 0.86. It is not yet clear if soil groups have any consistency in the amounts of Al, Fe, and Ti they contain. Consistency would allow prediction of soil contamination based on soil group.

Conclusions/Outcomes/Impacts:

A significant range was found in composition of parameters important for biomass combustion. There is highly variable and considerable soil contamination, as high as 20% of the dry bale weight. Ash content is very highly related to energy (BTU) content of the bale. It may be possible to accurately estimate energy content of bales, just be using Ash content to predict BTU. BTU analysis is over 20-30 times more expensive than ash analysis. The highest rate of soil contamination lowered energy content of the bale by almost 50%. For residential-scale combustion, it probably will be necessary to rate hay pellets for soil contamination. With another year of data it should be possible to determine whether mulch-type hay is appropriate for all scales of biomass combustion, or whether some or all of it would be most appropriate for light industrial and industrial combustion.

Outreach:

Another year of data collection is necessary before coming to firm conclusions and distributing them through meetings and publications.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

A second year of sampling will provide the database necessary for evaluating the northern NY mulch hay crops as a potential source of bioheat.

Person(s) to contact for more information (including farmers who have participated:

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Photos and Tables

See individual report at http://www.nnyagdev.org/index.php/bio-energy/production/

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Optimizing Grass Biomass Yield and Quality for Combustion

Project Leader(s):
J.H. Cherney, Dept. of Crop & Soil Sciences, Cornell University
Q. Ketterings, Dept. of Animal Science, Cornell University
D.J. Cherney, Dept. of Animal Science, Cornell University
M. Davis, Cornell Agric. Exp. Station, Willsboro, NY

Collaborator(s):
Cooperating Producers:

Background:

Northern NY imports most of its energy and is therefore heavily reliant on these greatly fluctuating outside energy sources. Grass biomass for residential and light industrial heating has the potential to be a local closed-loop energy system, with the grass produced, densified and marketed locally. The energy content in pelleted grass is similar to premium wood pellets, and the efficiency of a grass bioheat system has been estimated at 14:1 (energy output:energy input). Conversion efficiencies of other biomass processes rarely exceed a 4:1 ratio and can be considerably lower than that.

In general, the federal government continues to ignore the potential for grass bioheat, while the interest in the Northeast continues to increase. NYSERDA has funded several projects in NY to evaluate grass pelleting and the use of grass pellets for residential heating. Heating appliances are being evaluated in two NYSERDA projects for effective combustion, focusing on emissions issues. SUNY-Cobleskill has developed a mobile grass pelleting machine that is currently being tested on farms in the Hudson Valley. Enviro-Energy, LLC in Delaware County is currently pelleting grass for residential heating. Other densification equipment capable of generating various briquettes also are being tested with grass in the Northeast. The northern NY region would have the most to gain from adoption of a grass bioheat industry, compared to other regions in the Northeast.

The impact of organic matter application (manure or compost) on tradeoffs between grass biomass production, composition, and soil test N, P and K dynamics needs to be investigated. Phosphorus content of grass has very little impact on combustion, but soil test P needs to be monitored to ensure P levels do not exceed the environmental (soil-specific) threshold. Recent studies with corn showed compost increased soil C content and moisture holding capacity while liquid manure tended to sustain C levels and inorganic fertilizer applications decreased C reserves and moisture holding capacity over time. It is unknown what the dynamics would be under grass systems. It is well-known that harvest management has a major impact on grass yield and composition. Warm-season grasses tend not to persist if harvested more than once a year, while cool-season grasses have optimum yield with two harvests per season. Mature grass, left cut in the field for a week or more to leach, will result in reduced ash, N, K and Cl content.

For economically viable grass production we want to maximize forage yield. The biomass should be relatively low in total ash content (primarily silica), but more importantly relatively low in nitrogen (N), potassium (K), chlorine (Cl) and sulfur (S) content. The basic factors influencing N, K, Cl, and silica uptake by grasses include plant species, soil type, plant water uptake, N, K and Cl fertilizer use, manure application, and harvest management. Warm-season grasses such as switchgrass have lower water uptake than cool-season grasses such as reed canarygrass or tall fescue, with potentially lower silica and total ash content. Water use efficiency may also result in higher yields for warm-season grasses under limited rainfall, which can be assessed by including an irrigation treatment. Silica is much more available to grasses in clay soils compared to sandy soils, which can result in increased total ash content of grasses grown on clay soils.

Switchgrass currently is the top warm-season grass of choice for biomass in much of the country. Results obtained from switchgrass in this study will readily apply to other warm-season grasses. Reed canarygrass and tall fescue were also chosen for their high yield potential, as well as their superior persistence for northern NY winters. Results from these grasses can easily be transferred to other cool-season grass species with biomass potential. Maximum yield and persistence for warm-season grasses occurs with one harvest per season, while cool-season grasses have considerably more productivity with two harvests per season.

Methods:

It is impossible to evaluate all important factors and their interactions in field-scale studies, therefore small plot work is required. We selected three species with high yield potential (switchgrass, reed canarygrass and tall fescue) and focused on the impacts of (1) soil type, (2) soil moisture, and (3) fertility management, on yield and composition of these grass species.

Thirty-six species blocks were established [12 blocks each of switchgrass (Cave-in-Rock), reed canarygrass (Rival) and tall fescue (KY-31)], each 20’ x 60’. Of these 36 blocks, 18 are on a sandy site and 18 are located on a clay soil, both on the Willsboro research farm. It took 3 years to fully establish switchgrass at both sites. For biomass endophyte-infected tall fescue and high alkaloid reed canarygrass would be preferred, as both are more vigorous and persistent than their higher quality counterparts. No high alkaloid reed canarygrass seed is currently available, but we did find a source of endophyte-infected tall fescue. We tested for and confirmed the endophyte infection. The six treatments applied to each block were:
1) Check treatment with no additional manure or fertilizer.
2) Dairy manure, 40 tons/a wet-basis, early spring application.

3) Composted dairy manure, similar rate of dry matter as with dairy manure.
4) 150 lbs/a of N fertilizer for cool-season grasses, split-applied. 75 lbs/a for switchgrass, no P or K fertilizer.
5) 100 lbs/a of 0-0-60 plus phosphorus at 50 lbs/a of 0-46-0. (same N rate as #4).
6) Recommended rate of potassium as KCl (100 lbs/a of 0-0-60) (same N & P rates as #5).

Switchgrass blocks were sprayed with Roundup in early spring. Both dairy manure and composted dairy manure were applied in early spring at greenup of the cool-season grasses. Samples of manure and compost were taken to DairyOne labs for analysis. Nitrogen, P and K fertilizers were applied to cool-season grasses at spring green-up. Nitrogen fertilizer applied was 100 lbs/a. N, P, and K were applied to switchgrass in mid-May, with 75 lbs N/a. Three of the six field replicates were irrigated in 2011, to assess the impact of moisture availability on yield and quality.

Reed canarygrass and tall fescue were harvested July 6 and 7, 2011. The remaining 50 lbs of N fertilizer was applied following harvest. The single harvest of switchgrass was taken after frost on Oct. 11, 2011. A second harvest of reed canarygrass and tall fescue was also taken at that time. Soil samples were taken from all plots following the fall harvest. Plant samples from all harvests were sent to Dairyland Labs for analysis.

Results:

Grass stands appeared as healthy as they have been to-date, except for reed canarygrass on the sandy soil. Those stands continue to be weak. Weeds were effectively controlled in switchgrass with an application of Roundup just prior to switchgrass breaking dormancy in the spring. Broadleaf weeds were controlled in the cool-season grasses. A few wild grasses were present in the reed canarygrass on the sandy site, but this would not have a significant impact from a biomass standpoint.

Irrigation following spring harvest had minimal impact on cool-season grass yields for the season. Irrigation also had minimal impact on switchgrass yield, if plots received any of the fertilization treatments. Check plots that do not receive any fertilization treatments were the exception. Switchgrass check plots on sandy soil averaged 32% higher yield when irrigated, and check plots on clay soil averaged 39% higher yield when irrigated. Irrigation of switchgrass check plots resulted in yields similar to all the fertilization treatments. Irrigation results in 2011 were likely impacted by the excessively wet spring season.

Switchgrass once again produced the highest yields, with 5.4 tons/acre on the sand site under fertilized conditions (Fig. 1), and 6.0 tons/acre on the clay site (Fig. 2). Switchgrass yields were slightly less in 2011 compared to 2010. Tall fescue yielded higher than reed canarygrass on the sandy soil, but lower than reed canarygrass on the clay soil. Both cool-season grasses were very low yielding if commercial N fertilizer was not applied.

2011 showed differences among commercial fertilizer treatments for the first time in three years. The NPK treatment on cool season grasses was higher yielding than either the N or NP treatments. Commercial fertilizer treatments had a small effect on switchgrass yields. Cool season grasses with manure application produced similar yields to the NPK commercial fertilizer treatment. Once again, compost-treated cool season grasses yielded much less than other treatments, averaging 50% lower yields than manure treatment (Fig. 1 & 2). There was no difference in yield, however, between compost and manure for switchgrass. It is not clear why cool-season grasses are so unresponsive to dairy manure composted, the same total amount of organic nitrogen is applied with either compost or fresh manure.

From a biomass composition standpoint, the elements of most concern are chlorine, potassium, nitrogen, and total ash content. The elemental concentration response to treatments has been very consistent over the 3 years of treatment applications. Adding potassium in either KCl, manure or compost, significantly increased the forage K content (Fig. 3). The same was true for chlorine (Fig. 4), with very high chloride uptake for the manure treatment.

Ash content tends to follow the patterns of K and Cl uptake, with higher ash in manure and compost treatments (Fig. 5). Nitrogen content (shown as CP, Fig. 6) is similar for all treatments except compost and the check. In all cases, switchgrass is much lower in ash and elemental concentrations than the cool-season grasses, making it a more acceptable biomass combustion feedstock.

Conclusions/Outcomes/Impacts:

Switchgrass yields are good, regardless of any fertilization, making this a very desirable biomass species. The low-alkaloid reed canarygrass 'Rival' has not been very vigorous, uncharacteristic of reed canarygrass in general. Biomass composition has been greatly impacted by fertility treatments. Both manure and compost contain large quantities of highly available chloride, greatly increasing the Cl content of the forage for cool-season grasses, but having much less impact on switchgrass. Irrigation in 2011 had minimal impact on forage yields, except that it increased switchgrass yield considerably, in plots that received no fertility treatments. The excessively wet spring impacted the results, hopefully 2012 will be normal or below normal in rainfall at Willsboro, to better evaluate the influence of water availability on yield and composition.

Outreach:

One more year of data collection is necessary before coming to final conclusions and distributing them through meetings and publications.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

To evaluate the lingering effects of manure and compost on yield, biomass composition, and persistence of perennial grasses we need to collect four years of data from this experiment.

Acknowledgments:
We gratefully acknowledge the Cornell Agricultural Experiment Station for providing the irrigation equipment that will be used in this experiment in 2011, for purchase of a bomb calorimeter to measure energy content of biomass samples.

Reports and/or articles in which the results of this project have already been published.

Cherney, J.H. 2012. Grass Biomass as an Alternative Energy Source. New Brunswick (Canada) Soil and Crop Improvement Association Annual meeting, Mar. 1-2, 2012, Sussex, NB, CAN.

Person(s) to contact for more information (including farmers who have participated:

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Photos

See individual report at http://www.nnyagdev.org/index.php/bio-energy/production/

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Breeding Alfalfa Varieties with Resistance to Alfalfa Snout Beetle

Project Leader(s):
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- E.J. Shields, Professor, Department of Entomology; 4144 Comstock Hall; Cornell University; 607-255-8428; es28@cornell.edu
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- J. Hansen, Sr. Research Associate, Department of Plant Breeding and Genetics; 101 Love Lab; 607-255-5043; jlh17@cornell.edu

Collaborator(s):

Chuck Burnett, Seed producer, Caldwell, ID.
Mike Hunter, Extension Educator in Jefferson County, worked with growers to identify a field site for a new trial established in spring 2008, 2009 and 2011.

Cooperating Producers:

Lewis County: Alfalfa snout beetles were collected along the roads just outside of Lowville, NY
Jefferson County: The alfalfa trials were planted on land prepared and owned by Doug Shelmidine, Sheland Farms in Adams, NY

Background:

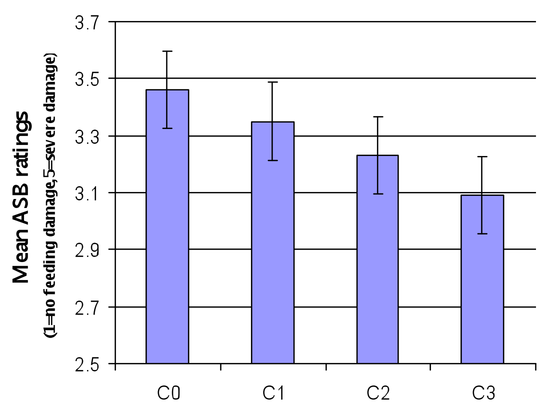
Alfalfa snout beetle (ASB), *Otiorhychus ligustica*, is the most destructive insect pest of alfalfa in Northern New York (NNY), and is continuing to spread. Alfalfa snout beetle is currently infesting nine NNY counties and has invaded Canada across the St. Lawrence River. Otherwise, there is no other known infestation of this insect in North America.

Alfalfa snout beetle was introduced from Europe into the Port of Oswego during the middle to late 1800's in ship ballast. Alfalfa snout beetle was first discovered as a problem around 1930 after alfalfa was introduced into Oswego County. This pest causes severe yield and stand losses on alfalfa by larval feeding on alfalfa roots. New infestations are often mistaken for winter injury since the majority of plants die after the last harvest and before spring growth. With other introduced insect pests, two combined strategies have been effectively used to reduce the insect populations to manageable levels. These strategies are 1) identify and incorporate resistance genes into acceptable alfalfa varieties (breeding for resistance) and 2) identify and establish in NNY biological control organisms (entomopathogenic nematodes) from the native home of ASB.

None of the alfalfa varieties grown in northern USA during the 1990s appeared to be resistant when grown on a field heavily infested with ASB. In 1998 at Watertown, NY, the perennial *Medicago* core collection and other germplasms were evaluated for resistance/tolerance to root feeding damage by ASB by visually rating individual plants with a score from 1 to 5 (1 = no root damage, 5 = dead plant). The ASB damage score for 173 plant populations ranged from 3.7 to 4. This variability suggests that resistance genes may exist at a low level in a few populations. Therefore, we initiated recurrent selection to increase the level of resistance in the most resistant populations.

Because of the time-consuming and unreliable nature of field screenings, a greenhouse screening method was developed by E. J. Shields and A. Testa with funding from the NNY Agricultural Development Program. With this greenhouse screening method, the ASB population pressure can be controlled by the number of eggs applied uniformly to each flat and by the length of time that the larvae are allowed to feed on the alfalfa roots. Thus, plants with a low level of resistance can be selected and, over several cycles of selection, the frequency of resistance genes can be increased in several alfalfa populations. The first cycle of selection was completed in 11 populations in 2003 and selection has continued at the rate of one cycle per year.

An experiment was completed in the fall of 2006 under controlled greenhouse conditions to determine progress from selection. Significant progress was realized through three cycles of recurrent phenotypic selection. Averaged across alfalfa populations, root damage visually scored on a 1 (no root damage) to 5 (severe root damage) basis was 3.46 for the base populations, 3.35 for Cycle 1, 3.23 for Cycle 2, and 3.09 for Cycle 3 (see Figure 1 below). One population had a difference of more than a whole scoring unit between Cycles 0 and 3. This trend is significant and suggests that more improvements could be made by further selection. These data are the first indication that progress from selection can be made in increasing resistance to ASB.



Seed was produced in pollination cages in Idaho in 2007 in order to have enough seed of the advanced generation alfalfa selection for use in establishing plot trials in ASB-infested fields during spring 2008, 2009 and 2011 at Sheland Farms. This field research will allow comparison of Cycles 0 and 4 (as well as Cycle 6 in the 2009 trial and Cycle 8 in the 2011 trial) in three alfalfa populations to determine if the breeding efforts translate into differences in forage yield, plant stand, and root damage ratings in farmers' fields where ASB populations exist. Because of the unreliable nature of insect infestation in field trials, trials established in two different years are necessary for conclusions about increased resistance.

Cycle of selection and Root rating

CO	C1	C2	C3
3.57	3.13	2.96	2.30

Figure 1: Progress in breeding alfalfa snout beetle resistant alfalfa – results from a greenhouse evaluation. Root rating was from 1 (no damage) to 5 (severe damage).

Methods

Breeding for Alfalfa Snout Beetle Resistance

The number of alfalfa snout beetles collected for use in the greenhouse screening procedure has been over 10,000 each year (2010 and 2011). Alfalfa seedlings were inoculated with eggs collected from the beetles. Around 35 days after inoculation, plants with the least injury were selected, interpollinated and seed produced for the next cycle of selection.

Field Evaluation of Alfalfa Snout Beetle Resistance in Alfalfa populations

The trial seeded in 2009 was harvested for yield on May 21, July 12, August 6, October 12 in 2010 and on May 25, June 30, and August 2 in 2011. The alfalfa populations seeded in the 2009 trial included three base populations, three corresponding populations after selection for four cycles of improvement for alfalfa snout beetle resistance, and two advanced cycle 6 populations. A new trial was seeded in 2011. The entries in this trial included two base populations, two corresponding populations after selection for either four, seven or eight cycles of improvement for alfalfa snout beetle resistance, and one cross of advanced germplasm.

Results

Breeding Program for Resistance to Alfalfa Snout Beetle

In 2010 and 2011, we completed the eighth and ninth cycles of selection for resistance in 7 alfalfa populations. Plants with the least injury were selected and interpollinated within populations to produce seed for the next cycle of selection. Since 2003, a total of more than 160,000 plants have been evaluated for resistance to ASB. About 14,500 plants were evaluated in 2010 and 17,500 plants were evaluated in 2011.

Five grams of seed from the most advanced selection cycle in all seven populations has been sent to Chuck Burnett in Caldwell, ID, for increase to a few pounds of seed from each. This seed will be used to establish more field trials in coming years that will test the more advanced cycles of selection for field levels of resistance and yield.

Field Evaluation of Progress in Developing Alfalfa Snout Beetle Resistant Alfalfa

Trial #1, Sown in 2009

In the first and second production years, 'Seedway 9558' cycles 4 and 6 had significantly higher yield compared to Seedway 9558 (unselected or cycle 0)(Appendix, Table 1). 'Curculio resistant' cycle 4 had higher yield that Curculio resistant cycle 0 in the second production year. The other population, 'ASB selections' did not show significant yield improvement when comparing the advanced selections for alfalfa snout beetle resistance to the unselected populations. Between the second and third harvests in 2011, some color differences were noted among the plots. The advanced cycles of selections (cycle 6) tended to be a darker green color (rating average 2.9, 1 is light green and 3 is dark green) compared to the unselected populations (rating average 2.0). Since the alfalfa snout beetle larvae eat the alfalfa nodules where atmospheric nitrogen is fixed and is available for the alfalfa plants, the lighter green color may be an initial indication of more severe root feeding damage. At this same time, height of the plots was also measured, but differences were not associated with selection cycle. The average yield in 2011 of the unselected or cycle 0 populations was 4.11 tons per acre, of the cycle 4 populations was 4.33 tons per acre and of the cycle 6 populations was 4.70 tons per acre (Appendix, Figure 1).

Trial #2, Sown in 2011 The trial sown in 2011 was managed for good alfalfa establishment, but was not harvested for yield. This trial will be harvested in 2012 and beyond. Plant stands in the seeding year were excellent.

Conclusions/Outcomes/Impacts

In both the greenhouse evaluation and field evaluation of the breeding progress made in alfalfa resistance to the alfalfa snout beetle, positive results showed that the selection program is successful and can be used to find alfalfa seedlings that have some level of tolerance or resistance to root feeding damage. For these two evaluations, a limited number of populations and a limited number of cycles of selection were tested. From the 2012 NNYADP grant, we will have the seed to test more populations and advanced lines that have been in the breeding program that began in 2002 that have not been evaluated yet.

It is anticipated that the first alfalfa snout beetle resistant alfalfa variety, the Seedway 9558 cycle 7 population or NY1010, will be named and seed will be available for sale in 2014. Producers in the ASB infested areas of NY are eager to plant an alfalfa variety with tolerance / resistance to the beetle. Producers will need to be aware that an alfalfa variety with strong resistance to ASB may not be available until more cycles of selection are completed and more crosses are made.

Outreach:

Results of this research project were presented at:

-Meeting with Seedway and Allied Seed companies on Jan. 13, 2010 and Mar. 8, 2011

-Cornell Seed Growers Field Days on July 8, 2010 and July 7, 2011

-Cornell Cooperative Extension In-Service Conference on November 17, 2010 and November 16, 2011

-Jefferson County Field Day on August 2, 2011 at Sheland Farms
-New article by Kara Dunn in August, 2011
- Powerpoint presentation about the alfalfa snout beetle resistant alfalfa to grower's interested in raising their own nematodes on March 6, 14, and 15 in 2012 in Northern New York

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

The breeding program for resistance needs to continue so that more cycles of selection can be accomplished and more populations screened. Genetic improvement in alfalfa is accomplished by step-wise accumulation of numerous favorable genes. We expect as selection continues, that the level of resistance to alfalfa snout beetle will increase. Along with the breeding program, evaluation of the alfalfa improvement progress will be important to document. Larger field scale strip trial will be possible in the future once commercial quantities of seed are available.

Acknowledgments:

CUAES Hatch Funds, NE1010 Regional Research Funds, Seedway and Allied LLC.

Reports and/or articles in which the results of this project have already been published.

Two-Pronged Attack Thwarts Snout Beetles, Hay and Forage Grower, September 20, 2011

Research shows promise for controlling destructive alfalfa snout beetle, Cornell Chronicle, September 14, 2011

Person(s) to contact for more information (including farmers who have participated:

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Appendix with Figures and Photos: See individual report at http://www.nnyagdev.org/index.php/field-crops/research-projects/research-alfalfa-snout-beetle/

Northern NY Agricultural Development Program
2011 Project Report

Soybean Trials in Northern NY

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Collaborators:

Farmer Participant:

Ron Robbins, Sackets Harbor, Jefferson Co.

Background:

Soybean acreage in New York has increased from about 40,000 acres in 1990 to almost 300,000 acres in 2011. Most of the acreage increase has occurred in the Finger Lakes and Western NY regions. Nevertheless, soybeans were produced on over 6,000 acres in Jefferson County and almost 3,000 acres in the remaining NNY counties for a total of 9,000 acres in 2010. The probability of increased soybean acreage in NNY is great for the following reasons:

First, it is no longer too cool to produce soybeans in NNY because of development of high yielding Group I soybean varieties and the warmer summers. In the Quebec Province of Canada, 659,000 acres were planted to soybeans in 2010 and over 100,000 acres were planted in the Ontario Province between the NY/Canadian border and Ottawa. As global warming continues over the next several decades, NNY may prove to be the ideal rather than a marginal region for soybean production.

Second, the high price for soybean meal has more dairy farmers in NY considering either planting the crop themselves while putting in an on-farm soybean roaster or transporting their own soybean crop to a local roaster. Soybeans are a "low-input 'crop requiring planting, spraying once with Roundup (unless aphids or diseases appear and then an additional spray is required), and harvesting the crop in October. The lower inputs required for soybeans vs. corn makes it an attractive crop from a labor-management perspective, especially on smaller dairy operations. Also, the current high price of the crop makes it an ideal candidate as a cash crop, if liquidity is an issue for some dairy farmers. Soybean processing or handling facilities are now on the St. Lawrence River so transportation of the crop to these facilities would be relatively easy.

Third, soybeans do not suffer the same yield penalty that corn does with delayed planting. Soybeans can be planted through the first week of June with minimal yield penalty (1/3 bushel/day loss in central NY from May 15-June 15 compared with 1 bushel/day for corn until June 1 and then 1.5 bushel/day until June 15). Many soils in NNY do not dry out until early June and soybeans could be planted at this time with a limited yield penalty.
The summers are warming in NNY. The Watertown Airport averaged 1934 growing degree days from June 1-September 30 during the 1981-2010 period compared with only 1911 growing degree days during the 1961-1990 period. The cost of soybean meal is now approaching $400/ton and will probably remain high because of the increased demand in China. Soybeans may be better adapted to NNY than corn as indicated by the vast acreage of soybeans in Canadian Provinces directly north of NNY and the limited yield penalty for planting soybeans in June on slow-draining soils. Soybean acreage has increased in the Finger Lakes and Western NY regions because growers have substituted soybeans for dry beans, snap beans, oats, and other miscellaneous crops, which has proved to be a major boon to these producers over the last 5 years. Is it time for NNY farmers to reap the same benefits?

MATERIALS AND METHODS

The annual testing of soybean varieties was conducted at three locations in New York in 2011. Roundup Ready varieties in Maturity Groups 0, I and II were planted at the Aurora Research Farm in Cayuga Co., Neenan Brothers Farm in Lima in Livingston Co., and the Ron Robbins' farm in Sackets Harbor in Jefferson Co. The Sackets Harbor site in Northern NY averages about 2200 GDD from May through September.

The April-May period was the wettest ever recorded at the Watertown airport (about 5 miles east of the experiment on Rt.3 between Watertown and Sackets Harbor) so virtually no soybeans were planted in NNY in May (and only 14% statewide in NY). We planted Group 0/I and Group II varieties in separate tests at Sackets Harbor on 3 June.

Each individual plot consisted of ten 20-ft. rows spaced 7 inches apart. Each entry was planted with a small plot drill (6 foot wide Almaco) at seeding rates of 200,000 seeds/acre with four replications. A randomized complete block experimental design was used for all tests. We used 22 fluid oz/acre of Roundup Touchdown about 5 weeks after planting for weed control. Aphid numbers and white mold was low throughout the year.

Yields were determined by harvesting an 18-foot section of the seven center rows (4.08 feet) of each plot at all sites with a small plot combine (Hege 140C). Plant height and lodging scores (1.0-5.0 rating with 1.0=no lodging and 5.0=complete lodging) were taken at harvest. The Group 0/I and II tests were harvested at Sackets Harbor on 12 October. The Hege plot combine does not have weighing capabilities so the entire plot sample was taken to the lab to determine plot weight and then sub-sampled to determine moisture. All yields were adjusted to 13% moisture. We used the ANOVA test to determine significance for yield, seed moisture, lodging score, and height. All means were separated by Fisher's protected LSD (0.05) when significance occurred

RESULTS AND DISCUSSION

Growing Conditions

After the wettest April-May period on record, weather conditions turned somewhat dry and warm in June and July (4.62 inches with only 1.77 inches in July) in Jefferson County (Table 1). It continued warm in NNY for the remainder of the growing season with the 5th warmest June through September on record (at Watertown). Also, it was the 3rd wettest August through September period (at Watertown) so the June 3rd planted soybean trials did not experience stress during the pod-filling period. The Group 0/I varieties yielded 56 bushels/acre and Group II varieties yielded 53 bushels/acre (Tables 2 and 3). A light frost occurred at the Sackets Harbor site on 6 October when some late Group II varieties were in the R6.5 stage (leaves turning yellow), which probably reduced their yield and delayed dry-down.

Lodging and Harvest Moisture

Most Group I varieties at Sackets Harbor were within a couple points of 13% moisture at harvest (Table 2). Group I varieties averaged 13.0% moisture but Group II varieties averaged 17.2% (Table 3), probably because the light frost delayed dry-down of some of the Group II varieties that still had yellow leaves (R6.5 stage).

Yield-Group I test

The highest-yielding variety in the Group I test was a very early Group I variety, AG1031 from Asgrow (11% above the average yield of the test, Table 2). Other varieties that yielded much above-average (5% above the average) in the Group I test include HS 19A02 from Growmark FS Seeds, 1805R2 from Channel Bio, RPM DB1711RR from Doebler's, HS 19A11 from Growmark FS Seeds, and H16-10R2 from Hubner Seed. In addition, AG 1832 and AG1631 from Asgrow had above-average yield in the Group I test.

Yield-Group II test

The early Group II variety, AG2031 from Asgrow, had the highest yield (21% above-average) in the Group II test (Table 3). Other Group II varieties that yielded much above-average include AG2232 from Asgrow, 2292R2 from T.A. Seeds, H20-12R2 from Hubner Seed, SG2018 and SG2111 from Seedway, 38RY23 from Dyna-Gro , and AG2430 from Asgrow. In addition, HS 21A12 from Growmark FS Seeds, SG2410 from Seedway, HS 27A14 from Growmark FS Seeds, 2200R2 from Channel Bio, and AG2330 from Asgrow had above-average yield.

Conclusions:

The 2011 growing season in Northern New York was challenging because of the wettest April-May on record delayed soybean planting until June. The exceptionally warm June through September period (5^{th} warmest on record at Watertown) coupled with the late frost (October 6) allowed for very good soybean yields this year in NNY. If the current price remains above $11/ bushel, we expect soybean acreage in New York, including NNY, to increase next year. Because of the limited number of inputs for soybean production (minimum till, plant, spray Roundup, and harvest without drying in most growing seasons), soybean variety selection is one of the most important management decisions that affect yield. Hopefully, we can continue soybean variety trials in NNY to provide the ever-increasing number of growers additional information to use when making this crucial management decision.

Outreach:

The results of this study were shared with our field crop educators at our In-Service in Ithaca on November 16. Also, the information was presented at the Field Crop Dealer Webinar on November 21 in which 133 participants (targeted audience was industry folks) attended. Likewise, the results of this study were incorporated into our news article, entitled "Recommended Roundup Ready Soybean Varieties for New York" in our newsletter, **What's Cropping Up?** that was published in December of 2011 (Vol.21, No.4, p.1-2, on our web site at: www.fieldcrops.org.). Furthermore, the results will be incorporated into the recommended soybean variety tables in our **2013 Cornell Guide for Integrated Field Crop Management**.

Acknowledgments:

We acknowledge the support of Cornell University Agricultural Experiment Station for providing support for the soybean variety testing program. This allows partial support for a highly-skilled individual to transport equipment, plant, spray, and harvest the trials as well as to hire temporary help to assist in all field operations and process all field samples in the lab (plot weights, moistures, and data entry).

Table 1. Monthly and total precipitation and growing degree days (GDD, 86-50 F system) at the Watertown Airport during the 2011 soybean growing season.

	Precipitation	GDD (86-50 F)
Month	Watertown Airport	Watertown Airport
June	2.85	467
July	1.77	676
August	6.38	594
Sept.	4.98	396
Total	**15.98**	**2133**

Table 2. Yield, seed moisture, lodging score, and height of Group I Roundup Ready soybean varieties harvested at Sackets Harbor, NY on 13 October, 2011.

COMPANY/BRAND	VARIETY	YIELD	MOISTURE	LODGING	HEIGHT
		bu/ac	%	1-5 rating	cm
Asgrow	AG1031	62.3	12.7	1.0	69
Growmark FS	HS 19A02	60.3	12.8	1.0	72
Channel Bio	1805R2	60.2	13.2	1.0	65
Doebler's	RPM DB1711RR	60.0	12.4	1.0	68
Growmark FS	HS 19A11	59.3	13.1	1.0	62
Hubner Seed	H16-10R2	59.1	13.0	1.0	65
Asgrow	AG1832	56.7	13.2	1.1	72
Asgrow	AG1631	56.2	12.8	1.1	66
Growmark FS	HS 17A12	55.9	13.3	1.0	69
Asgrow	AG1431	55.2	12.5	1.0	69
Seedway	SG1711	54.9	13.0	1.0	67
Seedway	SG1911	54.5	12.9	1.0	65
Asgrow	AG1831	54.5	14.6	1.0	78
Dyna-Gro	34RY17	54.4	13.4	1.0	65
TA Seeds	1719R2	53.8	13.0	1.0	62
Channel Bio	0905R2	53.6	11.9	1.0	70
Asgrow	AG1931	53.4	13.6	1.0	77
Growmark FS	HS 13A11	52.8	12.6	1.0	60
Seedway	SG1311	52.2	12.3	1.0	62
TA Seeds	1209R	46.6	13.4	1.0	53
AVG.		**56**	**13.0**	**1.0**	**67**
LSD 0.05		**5**	**0.61**	**NS**	**6**

Table 3. Yield, seed moisture, lodging score, and height of Group II Roundup Ready soybean varieties harvested at Sackets Harbor, NY on 13 October, 2011.

COMPANY/BRAND	VARIETY	YIELD	MOISTURE	LODGING	HEIGHT
		bu/ac	%	1-5 rating	cm
Asgrow	AG2031	64.0	14.1	1.1	80
Asgrow	AG2232	62.2	17.2	1.1	86
TA Seeds	2229R2	58.5	15.2	1.0	68
Hubner Seed	H20-12R2	58.4	13.7	1.0	70
Seedway	SG2018	58.3	13.7	1.0	81
Seedway	SG2111	57.5	14.0	1.0	73
Dyna-Gro	38RY23	56.5	16.0	1.1	75
Asgrow	AG2430	56.2	15.2	1.0	78
Growmark FS	HS 21A12	54.3	15.7	1.0	71
Seedway	SG2410	54.1	19.0	1.2	87
Growmark FS	HS 27A14	53.9	18.7	1.3	86
Channel Bio	2200R2	53.7	15.5	1.1	70
Asgrow	AG2330	53.4	18.6	1.1	76
TA Seeds	2599R2	51.0	19.4	1.4	90
Dyna-Gro	V25N9RR	49.5	19.5	1.1	78
Asgrow	AG2431	43.2	19.7	1.1	72
Doebler's	RPM DB2511RR	42.6	18.9	1.1	70
TA Seeds	2890R	41.1	19.9	1.2	86
Asgrow	AG2532	41.0	19.5	1.1	79
AVG.		**53**	**17.2**	**1.09**	**78**
LSD 0.05		**5**	**0.80**	**0.21**	**7**

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Corn Hybrids for Grain Production in Northern New York

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Background:
Corn is the primary row crop grown in northern New York (NNY), harvested from about 140,000 acres in 2010. Jefferson and St. Lawrence counties rank in the top 10 NY counties in terms of corn acreage, and Clinton and Lewis counties are not far behind. Corn provides essential feed for the dairy industry in NNY. About 60,000 acres of corn were harvested as grain in 2010, representing 43% of total corn acreage in NNY. Although NNY corn grain acreage was down relative to silage acreage compared to 2009 values, grain acreage has consistently increased as a percentage of NNY corn acreage over the past decade (see Figure 1). With ethanol production facilities in NY operational, corn grain production and marketing opportunities for NNY farmers continue to grow. The grain produced by corn hybrids also is a major contributor to silage yield, so grain yield evaluation provides an indication of which hybrids would be good candidates for silage use. It is important to evaluate silage quality on these hybrids as well, but seed companies will often enter their hybrids into grain evaluation trials as a first step in determining what is worth marketing at all in the region. Thus grain yield evaluations of commercial hybrids provide essential comparative information to farmers interested in grain production in NNY and to seed companies who make marketing decisions based initially on performance in grain yield trials, and then may do subsequent silage evaluations. Since NNY farmers spend about $6 million annually on corn seed for grain production, these evaluations are critical to the profitability and productivity of this important agricultural enterprise. Corn seed prices have climbed rapidly, making it more and more important to provide growers with information that allows them to choose hybrids that are well adapted and likely to be productive in the NNY region.

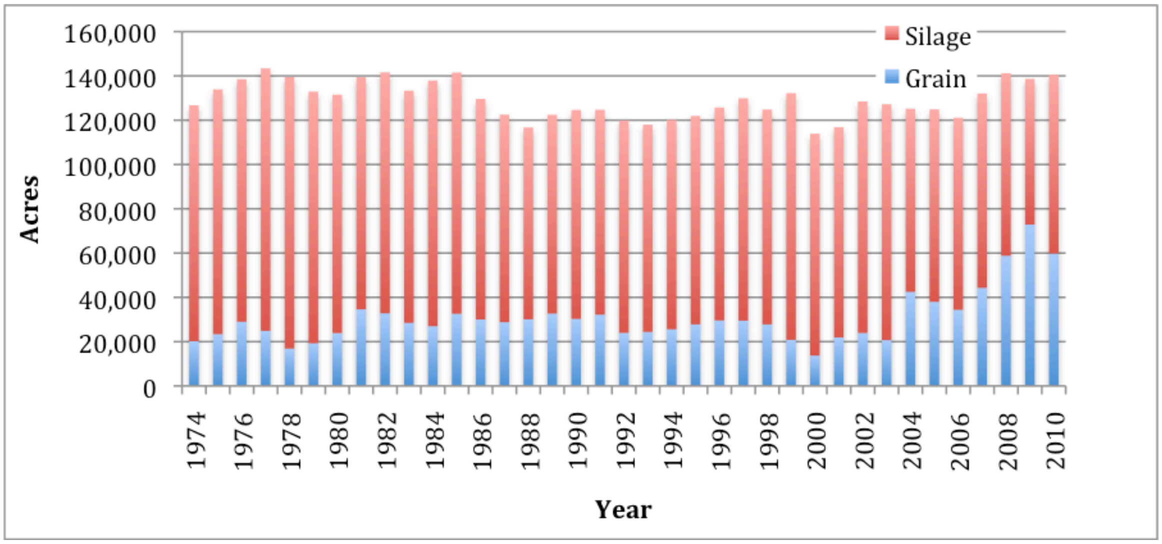

Figure 1. Acres harvested as corn grain (blue) and corn silage (red) in Northern New York from 1974 through 2010.

Methods:

We evaluated early maturing hybrids (1400-1900 growing degree days, 70-90 days relative maturity) at one location in NNY (Chazy in Clinton county) to identify hybrids that can meet the needs of farmers in the region. Seed companies marketing corn in New York were contacted to request entry of their early maturing commercial hybrids into evaluation tests. Hybrids were compared for grain yield, maturity, stalk and root quality, and disease and insect resistance. Each hybrid was planted in three replications per location, with each replication consisting of a 1/500 acre plot (two rows, 17.5' long). Plots were thinned at the 6- to 7-leaf stage to a density of 28,000 to 30,000 plants/acre. Data was collected at thinning time (late June to early July) on plant counts. In September, plots were evaluated for early-season stalk lodging, root lodging, and animal damage. At harvest time (October or November), data were collected on final stalk and root lodging, grain weight, and grain moisture. These data were used to calculate grain yield per acre and yield:moisture ratio (a measure of hybrid efficiency in producing high yield under short-season conditions). Evaluation results were published in the 2011 Corn Report (annual data) and will be included in the 2013 Cornell Guide for Integrated Field Crop Management (multiple year results).

Results:

The 2011 growing season in northern New York as a whole was favorable for corn. Wet conditions in May slowed down some planting operations, but generally favorable moisture and temperatures throughout the season in NNY provided a very good growing environment, particularly in contrast to many other parts of the state where very droughty conditions affected the crop at flowering time. Twenty-four eastern New York counties were declared disaster areas due to the effects of hurricane Irene in late August and/or tropical storm Lee in early September, including Clinton, Essex, and Lewis counties in

NNY. Several sites had severe root lodging due to these storms, including our location at Chazy. State average grain yield was 133 bu/A – down from the record 2010 yield of 150 bu/A but still the 4th highest average grain yield on record. At Chazy, the average yield for our hybrid test was 183 bu/acre, despite the storm-induced root lodging.

Results from the hybrid evaluation trial are shown in Table 1. The quality of our testing data this year was excellent, as reflected in the low coefficient of variation (CV) for yield (5.6%). This very low CV for yield indicates that the values in this table are reliable and not overly influenced by random variation in the testing field. Generally, a yield CV below 15% is considered evidence of high quality data.

Hybrid yields average 183 bu/acre and ranged as high as 206 bu/acre. Grain moisture at harvest was quite spread out, with some hybrids at about 23% and others as high as 30%. These differences could reflect significant variation in drying requirements for harvested grain – earlier maturing hybrids with drier grain at harvest time would require much less fuel expenditure to reduce moisture to acceptable levels for grain storage and marketing.

This type of variation is reflected in the yield:moisture ratio, which is an indicator of hybrid efficiency in producing high yield under short-season conditions. This ratio is one of the best guides to choosing a hybrid with excellent yield potential and appropriate maturity. The absolute value of the yield:moisture ratio at any given site is not important, but rather the relative values of the hybrids at that site. Thus hybrids like Hyland HLB 32R, Hyland 8166, and Growmark FS 3989VT3 looked especially good this in this environment (i.e., they had high yield:moisture ratios).

As a cautionary note, growers should choose hybrids based on multi-year and multi-location data whenever possible, since any hybrid can have a “banner environment” but not necessarily hold up as strongly over a range of different locations and growing seasons. This data will be incorporated into the results in the upcoming Cornell Guide for Integrated Field Crop Management, which provides that multi-year summary.

The results in Table 1 summarize information on a broad array of commercially available hybrids, allowing farmers and seedsmen to compare NNY-based data on productivity and adaptation of hybrids from various seed companies.

Conclusions/Outcomes/Impacts:

Data in the hybrid production table in this report shows a number of hybrids that had excellent performance in NNY in 2011. However, hybrid choices should always be made based on the most comprehensive data available, usually multi-year and/or multi-location data. Such data is available in the Cornell Guide for Integrated Field Crop Management and this publication should be consulted, in combination with the individual test data presented here, when making hybrid choices.

Outreach:

Results of 2010 testing were published in the 2010 Hybrid Corn Grain Performance Trials report (Plant Breeding Mimeo 2011-1, also available on the web at http://plbrgen.cals.cornell.edu/cals/pbg/programs/departmental/corn/index.cfm) and were incorporated into the tables of recommended hybrids in the 2012 Cornell Guide for Integrated Field Crop Management (Cornell University, 2011, also at http://ipmguidelines.org/Fieldcrops/content/CH03/default-2.asp). These results are available for farmer and seed company use in selecting hybrids best adapted to the challenging soils and climates of NNY. The publications are distributed through extension offices and at various extension and outreach meetings. Results from 2011 trials, which were harvested in late fall, are available in the 2011 Hybrid Corn Grain Performance Trials report (Plant Breeding Mimeo 2012-1, also at http://plbrgen.cals.cornell.edu/cals/pbg/programs/departmental/corn/index.cfm) and will be incorporated into the tables of recommended hybrids in the 2013 Cornell Guide for Integrated Field Crop Management (to be published by Cornell University in fall 2012).

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education:

In future years when funding is available to support the additional costs of travel to the NNY region, we will plan to continue testing hybrids in NNY to ensure that farmers and seed companies have a solid basis for their choices of corn grain hybrids for this important region of the state.

Acknowledgments:

Funding by the Northern New York Agricultural Development Program and by the participating seed companies is gratefully acknowledged. We also acknowledge some general support for corn breeding and testing from the Cornell University Agricultural Experiment Station through Hatch Project NYC149446, "Breeding Pest Resistant and Stress Tolerant Corn for more Sustainable Production Systems." We acknowledge the assistance of Dr. Mike Davis with planting, general management, and harvest of the trial at the Miner Institute in Chazy, and the Miner Institute for use of field space.

Reports and/or articles in which the results of this project have already been published:

Smith, M.E. 2012. 2011 New York Hybrid Corn Grain Performance Trials. Cornell University, Cornell Cooperative Extension, Plant Breeding and Genetics 2012-1. 20 pp.

Smith, M.E. 2011. Hybrid selection for corn grain hybrids. pp. 51-53. In: Cox, W.J. and L. Smith (eds.) 2012 Cornell Guide for Integrated Field Crop Management. Pesticide Management Education Program, Cornell University, Ithaca NY. 158 pp.

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Websites:
Smith at http://plbrgen.cals.cornell.edu/cals/pbg/people/faculty.cfm?netId=mes25
Corn variety testing at
http://plbrgen.cals.cornell.edu/cals/pbg/programs/departmental/corn/index.cfm

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Table 1. 2011 Early maturity hybrid evaluation data from Chazy.

Brand	Hybrid	Grain Yield, bu/A	% Mois-ture	Yield: Mois. Ratio	% Stalk Lodge	Root Lodge Score*
Hyland	8166	171	22.7	7.5	4	0.0
Channel Bio	185-80VT3P	168	24.2	7.0	5	2.2
T A Seeds	TA 290-31	171	25.0	6.9	5	3.7
Hyland	HL B32R	195	25.2	7.8	1	2.7
Doebler's	329GRQ	180	25.7	7.0	7	3.3
Growmark FS	3989VT3	190	25.8	7.4	3	0.0
T A Seeds	TA 370-11	184	26.6	6.9	3	1.5
Growmark FS	3808VT3	192	27.6	7.0	2	0.0
Growmark FS	4217XRR	193	28.1	6.9	3	0.7
T A Seeds	TA 451-20	206	28.3	7.3	0	1.8
Hyland	8234	179	28.7	6.3	2	1.3
Doebler's	RPM ®269HRQ™	162	29.3	5.5	2	3.7
Growmark FS	4212VP3	187	30.5	6.1	2	1.0
	MEAN	183	26.7	6.9	3	1.7
	S.D.	10	1.6			
	C.V.	5.6	6.2			
	LSD(.05)	17	2.7			

* Severe root lodging as a result of Hurricane Irene was rated in early September (0 = no lodging, 5 = completely lodged). This rating was done prior to Tropical Storm Lee, which would have added to root and stalk lodging totals.

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Managing Fertility to Increase Yields in Field Grown Vegetables

Project Leader(s):

Stephen Reiners, Professor of Horticulture (sr43@cornell.edu) – overall project advisor
Amy Ivy, CCE Horticulture Educator in Clinton/Essex Counties (adi2@cornell.edu) – overall project coordinator

Collaborator(s):

None for this phase of the project.

Cooperating Producers:

None for this phase, although several did submit their soil test results for group discussion/training purposes.

Background:

Vegetable production for fresh market sales is seeing a dramatic increase in recent years in NNY, fueled by the interest and demand from consumers for local food. There are many new and/or small scale growers in NNY who need training in how to best manage their crops, especially in our colder climate and short growing season.

While growers realize fertility is important, most of the newer and/or smaller scale growers in NNY have a poor understanding of how to optimize fertility to enhance the performance and yield of their various crops. Whether they are using organic or conventional sources, NNY growers could increase profitability by having a more strategic approach to managing the fertility needs of their crops.

Previous outreach efforts by the project team has confirmed that many growers' crops experience nutrient deficiencies by mid- season when crop needs are greatest. Plants experiencing deficiencies of the macro-nutrients nitrogen, phosphorus and potassium will have lower yields, and decrease economic performance of the farms. Few of our growers have a way to provide supplemental fertility if necessary. CCE can help growers identify crop deficiencies through foliar tests, but the growers need to have a plan to correct them.

In addition to mid-season deficiencies in all the macro nutrients (nitrogen, phosphorus and potassium) our experience indicates there are pH issues and uneven applications of amendments. Organic growers who rely on low analysis fertilizers such as fish emulsion need to be especially mindful of the rates to be sure their crops are receiving adequate nutrition. 'Hungry' crops are a common sight in NNY vegetable field, and the common approaches used by growers now are costly and often insufficient. The short growing season in NNY makes it especially important for growers to keep their crops growing at full capacity all season long to get the maximum yield possible in just a few months.

Methods:

For this first phase of the project, we urged growers to submit soil for nutrient analysis in the fall of 2011. We sent instructions, forms and general encouragement, and we received over 12 soil tests to work with.

We scheduled two day-long trainings in mid-February, one held in Watertown, the other in Plattsburgh, to reach as many NNY growers as possible. In the morning, Dr. Reiners gave an in-depth presentation on soil fertility, application methods, and organic and conventional options. We chose 5 soil test reports that reflected a range of growing conditions and soil nutrient levels for detailed discussions in the afternoon. Using group input Dr. Reiners explained which readings on each test called for attention and participants engaged in active discussions about how they might address the particular problems each test revealed.

Conclusions/Outcomes/Impacts:

By engaging the participants in the soil test results discussions, they were able to put into practice the principles they learned in the morning sessions.

In their program evaluations, the total of 40 participants (20 at each location) indicated the following:

- 29 agreed or strongly agreed that testing their soil was worth their time and money
- 18 participants indicated they would begin testing their soil on a regular basis as a result of this program
- 13 already do plant cover crops but 18 said they would begin using cover crops this year
- 20 indicated this program convinced them that investing in irrigation would be worth the cost
- Of the 40 attendees, 17 indicated they follow organic practices, 7 follow mostly organic, and 12 use conventional practices
- Several commented on having learned that timing the fertilizer application with the growth stage of the crops can make a difference in production
- 14 stated they didn't know if they were applying an appropriate amount of fertility and would use soil test results in the future to fine-tune their applications

Outreach:

None yet so far, we're planning that for the next phase of this project, after March 31, 2012.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

In the pre-survey, several growers revealed an incomplete understanding of fertility management, especially in regards to organic production practices.

Based on the survey, evaluation and discussions during these two meetings it is clear our growers need more training on fertility management, especially for organic growers.

We would like to follow up with our program participants to reinforce their winter training and coordinate on-farm discussion groups around these topics.
We would like to conduct follow-up soil and tissue nutrient testing to help growers learn first hand the cause and effect of nutrient applications.

Person(s) to contact for more information (including farmers who have participated:

No participating farmers yet, we'll have them this coming growing season.
For now, contact the Project Leaders

Photos - none for this phase, we expect photos this summer in the field.

Northern NY Agricultural Development Program
2011 Project Report

Project Title: Management Strategies for Fall/Winter Greens Production in NNY

Project Leader(s):

Chris Wien, Professor of Horticulture – overall project advisor (hcw2@cornell.edu)
Mike Davis, EV Baker Farm Manager – conduct and coordinate research at the Willsboro Farm (mhd11@cornell.edu)
Amy Ivy, CCE Horticulture Educator in Clinton/Essex Counties – overall project coordinator (adi2@cornell.edu)

Collaborator(s):

Judson Reid , State Vegetable Specialist, Cornell Vegetable Program, western NY - advisor on field demonstrations and projects
Laura McDermott, State Vegetable Specialist, Capital District
Harris Seed Company – future distributor of the heat tape
James Dowd – Calorique – maker of the heat tape

Cooperating Producers:

Michael McCauliffe, Essex County
Adam Hainer, Essex County

Background:

Many Northern New York vegetable growers are interested in expanding their production through the winter to meet the demand for a year round supply of locally grown produce. Field production of storage crops is an important part of this expansion, but consumers want more than root and storage crops. They want fresh salad greens in the winter. While mustards and Asian greens are extremely hardy and can be grown in NNY winter, there is greater demand for spinach and lettuce-based salad mixes. Local consumers are willing to pay up to $12/pound for this product and higher end, locally operated restaurants are also clamoring for local salad greens year round.

Without any heat, spinach can be grown and harvested most of the winter in NNY, except for January and early February. If we add minimal additional heat, spinach can be harvested all winter. Lettuce is more cold sensitive and winter production could potentially be greatly increased with additional heat, but energy inputs are expensive and often cut into the profitability of the crop. The key question is – can we develop a system for heating the lettuce-growing environment inside the high tunnel that will increase both winter lettuce production and profitability?

Product development programs at *Harris Seeds* and *Calorique Inc*. are proposing that growers could use heating strips (manufactured by *Calorique Inc*. primarily for residential in-floor radiant electric heating systems) to warm high tunnel growing beds. These heating strips, which have not been commercially released yet, require very low wattage per linear foot, and might provide an economical way to enhance winter lettuce production. The objective of this study was to test the use of electric heat strips to warm the growing bed soil, and thereby increase lettuce growth rates during the winter months in northern New York.

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Methods:

Calorique Inc. provided the project with two types of heating strips, one that used 8 watts per linear foot of strip and one that used 15 watts per linear foot of strip. Each strip is composed of a four to five inch wide flat strip of plastic in which a grid of heating elements is embedded. The flat plastic strips come in rolls that can be cut to the desired length, but the manufacturer cautions that a single strip should not exceed 55' in length. Differential heating along the length of a strip starts to be a problem if it is more than 55' long. Heat strips for the experimental growing beds were 13' – 14' long. One of the cut ends was sealed with a waterproof vinyl mastic tape. On the other end of the strip, metal electrical connectors were crimped onto the strip and attached to a power cord-plug. All metal connectors were covered with protective plastic clips and the openings were sealed with silicone caulk to eliminate moisture.

A single heat strip was installed in the middle of each heated treatment growing bed according to the manufacturer recommendations. To install the heat strips, an 8 inch wide, 10 inch deep trench was dug down the middle of the bed, and an 8 inch wide piece of 1.5" thick rigid blue insulation was placed in the bottom of the trench. The heat strip was then laid on top of the insulation and covered with 8 to 9 inches of soil. The vinyl mastic tape sealed end was buried in the growing bed, while the end with the connectors and plug extended above the soil surface. Heat strip plugs were connected to thermostats that were plugged into electrical outlets. Separate electrical outlets were installed for each heated growing bed.

To reduce heat losses from the growing bed environment, low wire hoops were set along the beds containing heat strips,as well as some beds without heat strips, and covered with an inner layer of *Agribon AG19* rowcover, and an outer layer of 6ml greenhouse plastic.

This study was conducted in the 30' x 96' *Ledgewood* pipe-frame high tunnel at the Cornell Willsboro Research Farm. The long axis of the tunnel is oriented east-west, while the long axis of the 2.5' x 12.5' growing beds ran north-south. The growing beds are located to the north and south of a central isle that runs the length of the high tunnel, and each bed extends from the center isle to the sideboard of the high tunnel. This bed configuration was employed because it provides a large number of experimental treatment beds (32) while eliminating potentially confounding issues associated with bed proximity to either the side or center of the high tunnel.

Experimental treatments included:
Two types of lettuce

- *Black Seeded Simpson* head lettuce

- *Five Star* lettuce mix from *Johnny's Selected Seeds*

Four growing bed environments

- 8 watt/ft heat strips + low rowcovers
- 15 watt/ft heat strips + low rowcovers
- Low rowcovers without any heat strips in the growing bed
- Control (no heat strips or low rowcover)

Each type of lettuce was combined with each of the growing bed environments for a total of eight treatments. A randomized complete block experimental design was used with four replications. All growing beds received a 25 lb/1000sqft application of North Country Organics ProGro 5-3-4 granular fertilizer prior to planting. Growing beds were hand watered with a hose and wand as needed. Weeds were hand pulled.

An *Onset Hobo* weather station tracked soil and air temperatures in the following locations: soil temperature (1.5" depth) in an 8 watt heat strip bed with low rowcovers, soil temperature (1.5" depth) in an unheated bed with a low rowcovers, soil temperature (1.5" depth) in a control bed (no heat and no rowcovers), air temperature (8" above soil surface) over an 8 watt heat strip bed with low rowcovers, and air temperature (8" above soil surface) over a control bed.

Black Seeded Simpson seeds were started indoors under grow lights at the *Carriage House Garden Center* on January 1, 2012, and were transplanted into the Willsboro Farm high tunnel treatment beds on February 6, 2012 (Photo 1). Head lettuce plants were planted three rows per bed with 12" between the rows and 12" between plants within the row. The center row was planted at a 6" staggered offset from the outer rows. *Five Star* lettuce mix was direct seeded into the beds with a four-row pinpoint seeder (seeds were placed in every other hopper, so two rows were seeded per pass) on February 8, 2012. Lettuce mix rows were spaced 4" apart with six rows per bed.

Heat strips were switched on every night from 4:00pm to 9:00am, and turned off during the middle of the day. Low row covers were in place every night and on cloudy days, but were removed on sunny days to allow the plants to receive more sunlight and prevent overheating.

Lettuce was harvested from all the treatment beds on March 30, 2012 (Photo 2). Each half of each treatment bed was sampled separately in order to quantify production differences between the half of the bed nearest the tunnel sidewalls and the half of the bed nearest the middle of the tunnel. Additionally, center rows and edge rows in each half of the bed were sampled separately, so there were a total of four sampling zones in each growing bed: center row(s) of the interior half, edge rows of the interior half, center row(s) of the outer half, and edge rows of the outer half. A total of three *Black Seeded Simpson* heads were harvested and individually weighed from each of the four sampling areas on the transplanted head lettuce treatment beds. On direct seeded treatment beds, 30 cm sections of *Five Star* lettuce mix were cut (at ground level) and weighed from each of the four sampling zones. Prior to cutting, lettuce height measurements were taken for all lettuce plants and mixed lettuce stands.

Results:

Heat Strip Installation Method

Placing the heat strips directly on top of the 1.5" thick rigid blue insulation turned out to be bad idea because heat became trapped between the insulation and the plastic strip to such an extent that the insulation and parts of the heat strips melted (Photo 3). Melted heat strips then shorted out when they were turned on and caused the GFI electrical breakers to trip, and the beds to go unheated. The problem was discovered in the growing beds with 15 watt heating strips on February 7, the day after the head lettuce was transplanted into the beds. As a result the 15 watt treatments were discontinued, and only the 8 watt heat strips were turned on for the remainder of the study. No problems with the 8 watt heat strips were noted during the experiment. However, after the study was completed, an examination of the 8 watt heat strips did find some pockets of melted insulation.

Growing Bed Temperature Ranges

A plot of the temperatures recorded every five seconds from 2/10/2012 to 2/13/2012 (Graph 1) illustrates the benefits of the low rowcovers and the in-ground heat strips. It was notable that on nights when the outdoor temperature dropped into the teens (2/11/2012) and single digits (2/12/2012), the soil temperature at 1.5" depth in the heat strip + low rowcovers bed never dropped below 40 degrees Fahrenheit, and the air temperature never dropped below 32 degree Fahrenheit. In contrast, the air temperature 8" above the uncovered and unheated control bed dropped into the low teens during the night of 2/12/2012.

Lettuce Production Responses

Lettuce production responses to the growing bed environment treatments were consistent for the transplanted *Black Seeded Simpson* lettuce and the direct seeded *Five Star* lettuce mix. Lettuce yields were much higher in both the growing beds equipped with heat strips + low rowcovers, and unheated beds with low rowcovers, than in the unheated and uncovered control beds (Figure 1), illustrating that the low rowcovers had a major influence on lettuce production. Mean lettuce yields in the heat strip + low rowcovers beds were consistently higher than the yields in the unheated beds with low rowcovers. The production difference between the heat strip + low rowcover beds and the unheated beds with low rowcovers was entirely due to increased lettuce growth in the center row(s) of the beds that were positioned directly over the buried heat strips (Figures 2 &3). Lettuce growth in the edge rows of the heat strip + low rowcovers beds was no different than the lettuce growth in unheated beds with low rowcovers, indicating that the 8 watt per linear foot heat strips in our installation configuration did not noticeably impact lettuce growth across the entire growing bed surface.

The proximity of the lettuce plants to the high tunnel exterior also greatly influenced growth. For all three growing bed treatments, lettuce production was higher on the half of the bed furthest away from the high tunnel sides (Figures 4 & 5).

Lettuce Mix Germination Rates

On heated beds with low rowcovers, direct seeded *Five Star* lettuce mix emerged three days ahead of the unheated beds with low rowcovers, and eight days ahead of the unheated and uncovered controls (Table 1). For direct seeded lettuce the days to germination and emergence is critical for maximizing the productivity of the high tunnel, and accelerated germination rates could be a significant benefit of the heat strip technology.

Conclusions/Outcomes/Impacts:

While the heat strips provided a modest boost to lettuce production in the high tunnel, it is not clear that the heat strips make economic sense, and several problems with the heat strips need to be resolved. The narrow heat strips used in this study only increased lettuce growth in the middle of the growing beds and did not impact growth over entire growing bed surface. *Calorique Inc*. does manufacture a wider (11”) strip that pulls 11 watts per linear foot and should enhance lettuce growth across a wider section of the growing bed. A higher watt heat strip may also be more effective at maintaining optimal nighttime soil temperatures than the 8 watt strips. The 8 watt strips in this study kept nighttime soil temperatures above 40 degrees Fahrenheit, but was not able to maintain soil temperatures in a more preferable 60-65 degree range on cold nights. The wider 11 watt heat strips should be evaluated in future tests.

Heat strips should never be installed next to or on top of an insulating material that could trap heat. It is possible that the melting problems could be resolved by separating the bottom insulation from the heat strip with 2” to 4” of soil; alternative installation configurations also require further testing.

Low rowcovers were the big winners in this experiment as they markedly increased germination rates and lettuce production over the uncovered control beds, and no additional energy inputs were required. In future studies it would be interesting to examine how the combination of *Agribon AG19* and 6ml greenhouse plastic compares to other types of rowcover or rowcover combinations.

NNY market growers continue to look for innovative ways to extend the growing season and extend their sales season. There is keen interest in seeing a variety of tunnel structure options from inexpensive, simple structures to more elaborate, higher tech structures.

NRCS has funded at least 8 new high tunnels in NNY this year alone. Growers appreciate the opportunities we provide to visit various structures in use and to talk with those growers to learn from their experience. Ultimately, each grower needs to decide which system will best suit his or her own needs and interests. There is no single answer to this question.

Outreach:

We held two day-long programs on winter crops production:

- In Madrid (St. Lawrence County) with 10 growers in attendance (from Jefferson and St. Lawrence Counties)
    - Speakers were Judson Reid, Cornell Vegetable Specialist; Jan van der Heide, Bejo Seeds; and Amy Ivy, CCE Clinton County
    - Topics included new winter storage crops and varieties, a discussion of different types of season extension structures, winter crops production and an update on garlic production and current pests.
    - Of the 10 growers attending, 5 had been growing more than 5 seasons and 3 growers had various types of season extending structures. In the evaluations growers commented on new winter vegetables they intend to try as a result of attending this meeting: more root vegetables, colored carrots, parsley root, celeriac
- In Willsboro (Essex County) with 18 growers in attendance (from Clinton, Essex and Franklin Counties)
    - Speakers were Mike Davis, Judson Reid, Laura McDermott and growers Adam Hainer and Mike McCauliffe
    - Started at EV Baker Research Farm – viewed and discussed heat tape trial then compared 3 types of season extension structures: high tunnel, lower tunnel and caterpillar tunnel, pros and cons; followed by classroom discussion of winter crops production, pest control in winter greens, and cost and construction comparisons of the different types of structures. Ended with a visit to Carriage House Garden Center to see their 2 tunnels in greens production and 2 more tunnels getting ready for tomato and pepper production.
    - NRCS has funded at least 8 new high tunnels this year and several recipients attended this program to learn about different structure and crops options. Of the 18 growers attending, 6 had been growing for 2 seasons or less and 5 had been growing for 5 seasons or more.
    - In the program evaluations participants commented on getting new ideas for winter crops, tunnel within a tunnel options for cold protection, and took home ideas for the temporary caterpillar-type tunnels we demonstrated. The Willsboro farm has 3 different style tunnels that participants could compare, and growers in the group who had used each type commented on the pros and cons of each.

In the coming months we will post more information on Cornell's High Tunnel website and the NNY ADP website for grower access.

Next steps:

To follow up on the progress made so far we need to offer more field trips to other farms using various season extending structures. In addition, growers need more information on costs, estimated time for return on investment, training in using enterprise budgets that are currently available on Cornell's High Tunnel website (http://www.hort.cornell.edu/hightunnel/), and diversified market options to extend their sales season throughout the year. We also need more variety trials and enterprise budgets for various high tunnel crops, tailored to NNY markets and seasons.

Acknowledgments:
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Person(s) to contact for more information (including farmers who have participated:

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Tables and Figures

See individual report at:
http://www.nnyagdev.org/wp-content/uploads/2011/12/2011NNYADPReportSaladGreens2.pdf