

Northern NY Agricultural Development Program 2007-2008 Project Report

Production and evaluation of perennial grasses for energy conversion in Northern NY

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Cooperating Producers:

Miner Institute, Clinton County, NY; Belleville Central School District, Jefferson County, NY

Background:

The close proximity of agricultural land in the Northeast to major population and transportation centers makes this region ideal for development of bioenergy crops and industrial bi-products from energy conversion processes. Corn grain is the most widely used bioenergy crop for ethanol production in the Midwest. Grasses and legumes, used as feedstock for biofuel, have the potential to be more economical and environmentally sustainable than corn-ethanol production. Perennial grasses reduce greenhouse gas emissions and soil erosion by sequestration of carbon from the atmosphere and through production of an extensive root system.

Switchgrass (*Panicum virgatum* L.) has been selected as a model biofuel feedstock crop by the United States Department of Energy (DOE) due to its native geographic distribution and high biomass production. However, the majority of research conducted on switchgrass for the DOE was done in the Midwest where management practices and environmental conditions differ from those in Northeast. Thus, data obtained in the Midwest trials may not reflect how the perennial grass will perform in New York. Since yield is highly influenced by environmental conditions, we feel it is important to evaluate these grasses in as many bioregions of New York as possible.

In 2007, our research group was funded by the Northern New York Agricultural Development Program (NNYADP) to evaluate perennial grasses as a feedstock for

biofuel production. In addition to the funds from the NNYADP, our group also received funding for biofuel production trials by the New York Farm Viability Institute (NYFVI). In the spring of 2007, a cultivar evaluation trial with six replicates of 20 monoculture and 4 mixed plots of warm season grass species was planted in Jefferson County. An additional 12 field trials (five strip trials, seven replicated small plot evaluation trials) consisting of both monoculture and mixed species stands of several switchgrass and big bluestem cultivars, and other warm and cool season species were established in 2007. The perennial grass trials were planted in five diverse regions of New York. Through funding from this project both warm and cool season perennial grass trials were planted in the eastern region of Northern NY to determine which species and cultivars will generate the maximum biomass production. The goals are to identify high yielding and adapted grass species and cultivars that can be harvested in an efficient and timely manner and used for conversion to liquid fuels, gases and combustible products. Identification of these grass species and cultivars in NNY will benefit current and potential producers in the region by providing information on which grasses to establish for dedicated bioenergy production.

Methods:

Replicated warm and cool season perennial grass trials were established on the 9th of May at the Miner Institute in Clinton County, NY. Plots for both trials (3.5' X 15') each with six rows spaced six inches apart, were established in a randomized complete block design with six replications. Seed of the various trial entries (Table 1) were planted with a Carter (Carter Manufacturing Co., Brookston, ID) small plot seeder. For the warm season grass trial, 20 trial entries were planted in monoculture and four entries consisted of a mixture of two different grass species (Table 2). Seven trial entries of four cool season grass species (Tables 3 and 4) were established in the cool season grass trial. Both fields were plowed and fertilized (300 lb/A 10-20-20) before seeding. Data were collected on % stand and height for the warm season grasses. Yield data were collected from the cool season grasses harvested on a two-cut schedule (July 15 and September 2).

Results:

A first year stand of 40% or more has been reported to indicate successful establishment of warm season grasses. By this criterion, all of the grass species/cultivars had acceptable stand establishment (Table 5). The eastern gamagrass cultivar Pete and big bluestem Goldmine had the lowest stands (50 % and 67 %, respectively). The overall average stand establishment for the warm season grasses in trial was 83%. This is significantly higher than the average percent stand (62%) observed in the trial located in Jefferson County planted in 2007. The switchgrass cultivars Blackwell, Shelter, and Forestburg, had the highest 1st year stands (Table 5). The rankings are consistent with data regarding stand establishment of other warm season grass trials planted at various locations in New York State in 2007. Big bluestem cultivars and other warm season grass species did not establish as well as the majority of switchgrass cultivars. In terms of overall growth measured by canopy height, the switchgrass cultivars Cave-in-rock, Blackwell and Pathfinder performed well. There was significant weed pressure in the warm season grass trial, but this did not appear to inhibit overall stand establishment. Cool season grasses were the most prevalent type of weed in the plots. Incidence of disease was less than 5% for all grass cultivars.

The two cool season perennial bromegrass cultivars Peak and York had the highest first harvest yields (Table 6), followed by the reed canarygrass and the two fescue cultivars. The lowest yielding entries were Jose and Largo wheatgrass (Table 6). The two tall fescue cultivars had the highest 2nd harvest yields (Table 6) and also the highest total yields at 2.9 and 2.9 dry tons/acre, respectively. Cool season grass stands did not have any significant weed pressure, presumably since weeds were controlled in the corn crop the previous year and the cool season grasses grew quickly enough to shade out many competing weed seedlings.

Conclusions/Outcomes/Impacts:

Purchasing and planting good quality seed is critical to successful establishment of warm-season grasses. Also, producers should correct seeding rates for percent pure live seed, as each seed lot will vary in the amount of inert material in the seed bag. A quick germination test can be done to check seed quality. The protocol for this test can be downloaded from our project web-site (nybiofuels.info). Establishment of the warm season perennial grasses without the use of post-emergent herbicide applications resulted in plots with heavy weed pressure, yet good stands of the grasses were obtained in most cases. Competition with annual and perennial weeds is a common problem that has been reported in the literature in establishment years for warm season perennial grass field trials. Results from these trials will be compared with trials established in other regions of the state. A few of the warm season grass cultivars have been reported to have problems with winter survival. As a result, stand and yield data in 2009 may have different rankings from the trials in NNY than from other locations.

The mean dry tons/acre was lower from the cool season grass trial harvested at the Miner Institute (2.38) than the trial in Ithaca (5.0) in 2007. This difference was mostly due to the lack of nitrogen applied on grass regrowth at the Miner Institute.

Data from these trials already are providing information that is useful in establishing best practices for growers to obtain good stand establishment and higher biomass yields. Data to be collected in the next few years will provide even more useful information.

Outreach:

Information and data from this research trial was reported to extension educators at the Agriculture-Food-In-Service meeting in Ithaca, NY, held during the second week of November 2008. A field day was held in St. Lawrence County on the farm owned and operated by Tom Lee August 12, 2008, where a strip trial of perennial warm season grasses was established in 2007. Through personal conversations with producers attending the field day in St. Lawrence County, it was understood that the information provided was helpful for their future plans in planting these types of grasses. Because the warm season grasses take three years to produce a mature stand, we did not schedule a field day at the Miner Institute in 2008, but we plan to do so in 2009.

Some information relating to these trials and others in NNY have been reported in newspaper articles and news stories (please see appendices for a list of articles, press releases and news coverage relating to the research in NNY on grass for use as bioenergy feedstock).

Next steps.

Research on seed quality, germination and dormancy in relation to successful stand establishment is necessary to make gains in production of these grasses. Analysis of biomass harvested from these trials for quality characteristics of economic significance such as quantity and type of cell wall sugars, theoretical ethanol yield, ash and mineral content, and total BTU's are currently underway. Yield data of the warm season grasses established in the 2008 trial at the Miner Institute should be collected in 2009.

Acknowledgments:

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

Data from these trials have been reported in the 2008 Forage Breeding Project Annual Databook produced by the Forage Breeding project at Cornell University.

For more information:

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Appendices

Table 1. Common and scientific names of warm season perennial grasses established in small plot trials at the Miner Institute, Clinton County, NY.

Common name	Species
big bluestem	<i>Andropogon gerardii</i>
coastal panic grass	<i>Panicum amarulum</i>
eastern gamagrass	<i>Tripsacum dactyloides</i>
indiangrass	<i>Sorghastrum nutans</i>
switchgrass	<i>Panicum virgatum</i>

Table 2. Cultivar, common name, % pure live seed (PLS), seed tag label % quick germination, and seeding rate of perennial grass entries in cultivar evaluation trials.

Cultivar	Common name	% PLS*		% Seed tag quick germination	Seeding Rate lb PLS/A
Bonanza	big bluestem	72		80	12
Goldmine	big bluestem	56		68	12
Niagara	big bluestem	22		74	12
Pawnee	big bluestem	63		68	12
Atlantic	coastal	87		88	8
	panic grass				
Pete	eastern	84		30	10
	gamagrass				
Rumsey	indiangrass	86		78	10
Nebraska 54	indiangrass	92		67	10
Blackwell	switchgrass	86		31	10
Carthage	switchgrass	94		51	10
Cave-in-rock	switchgrass	95		71	10
Cave-in-rock***	switchgrass	95		37	10
Forestburg	switchgrass	77		21	10
Kanlow	switchgrass	93		86	10
Pathfinder	switchgrass	74		16	10
Shawnee	switchgrass	93		93	10
Shelter	switchgrass	86		22	10
Sunburst	switchgrass	98		98	10
Trailblazer	switchgrass	93		83	10
Nebraska 28	switchgrass	92		92	10
Cave-in-rock	Switchgrass	95	72	37	5
Bonanza	big bluestem			80	6
Sunburst Niagara	Switchgrass	98	22	98	5
	big bluestem			74	6
	Switchgrass	95	84	37	5
Cave-in-rock Pete	eastern			30	5
	gamagrass				
Niagara Pete	Big bluestem	22	84	74	6
	eastern			30	5
	gamagrass				

* % Pure live seed (PLS)

** Actual seeding rate is corrected for quick germination rate.

*** Cave-in-rock seed for this entry was stratified before planting

Table 3. Common and scientific names of warm cool season perennial grasses established in small plot trials at the Miner Institute, Clinton County, NY.

Common name	Species
wheatgrass	<i>Thinopyrum ponticum</i>
tall fescue	<i>Festuca arundinacea</i>
Reed canarygrass	<i>Phalaris arundinacea</i>
Brome grass	<i>Bromus inersis</i>

Table 4. Cultivar, common name, % pure live seed (PLS), seed tag label % quick germination, and seeding rate of perennial grass entries in cultivar evaluation trials.

Cultivar	Common name	Seeding Rate lbs /Acre
Jose	wheatgrass	40
Largo	wheatgrass	40
Enhance tall fescue	tall fescue	20
Bull tall fescue	tall fescue	20
Bellevue	reed canarygrass	20
Peak	brome grass	20
York	brome grass	20

Table 5. Cultivar, common name, height of canopy (two dates), seed height and % stand of perennial warm season grasses established at the Miner Institute, Clinton County, May 8, 2008.

Cultivar	Common name	9/3/2008	9/30/2008	6/30/2008	% Stand
		Height	Canopy Height	Seed Head Height	
		----- inches -----			
Bonanza	big bluestem	30	29	54	81.67
Goldmine	big bluestem	15	30	66	66.67
Niagara	big bluestem	28	26	45	80.83
Atlantic	coastal panic grass	30	34	-	78.33
Pete	e.gamagrass	32	34	-	50.00
Blackwell	switchgrass	30	40	53	90.83
Carthage	switchgrass	35	39	44	81.67
Cave-in-rock	switchgrass	34	43	52	85.83
Cave-in-rock	switchgrass	32	43	56	89.17
Forestburg	switchgrass	25	34	49	90.83
Kanlow	switchgrass	46	34	34	85.83
Pathfinder	switchgrass	30	44	56	88.33
Shawnee	switchgrass	30	40	53	83.33
Shelter	switchgrass	30	40	52	90.00
Sunburst	switchgrass	26	37	48	87.17
Trailblazer	switchgrass	30	41	57	88.33
Nebraska 54	indiangrass	34	34	41	85.00
Nebraska 28	switchgrass	26	39	50	84.17
Rumsey	indiangrass	32	32	32	79.17
Pawnee	big bluestem	24	34	55	80.83
Mixtures-1a	Cave-in-Rock/Bonanza	35	40	54	85.83
Mixtures-2a	Sunburst/Niagara	30	35	54	83.33
Mixtures-3a	Cave-in-Rock/Pete	40	37	49	89.17
Mixtures-4a	Niagara/Pete	36	30	56	75.00
				Trial Mean	82.56
				F-entry	19.77**
				LSD (.05)	5.60
				CV (%)	5.9

** Significant at 0.01

% Stand based on visual rating

Table 6. Cultivar yield of perennial cool season grasses established at the Miner Institute in 2008, harvested in a two-cut system.

Cultivar	15-Jul	2-Sep	Total Season
-- tons per acre dry matter --			
Jose Wheatgrass	0.70	0.87	1.57
Largo Wheatgrass	0.91	1.00	1.91
Enhance Tall Fescue	1.22	1.57	2.79
Bull Tall Fescue	1.35	1.59	2.94
Bellevue R. Canarygrass	1.39	0.86	2.24
Peak Brome	1.72	0.86	2.58
York Brome	1.69	0.93	2.62
Trial Mean (T/A)	1.28	1.10	2.38
F-entries	21.11**	23.55**	24.58**
LSD (.05)	0.24	0.20	0.29
CV (%)	15.7	15.4	10.3

Note:

** Significant at 0.01

Media Hits and Public Outreach for Perennial Grass/Bioenergy Research in NNY

The following media outlets printed or aired stories on grass-based agriculture research in NNY – grass as a feedstock for animal agriculture and for bioenergy production.

10-01-08 Empire State Farmer: Belleville-Henderson trials
 Sept 2008 Country Folks Grower
 Sept 2008 American Agriculturist: Tom Lee
 08/25/08 Country Folks
 08/13/08 Watertown Times Online
 08/13/08 TV 7 WWNY TV
 August 08 North Country Public Radio: Switchgrass Field Day
 07/29/08 Watertown Times: Switchgrass Field Day
 07/27/08 Sunday Advance News (St Lawrence County): Switchgrass Field Day
 07/27/08 Hay & Forage Grower: Switchgrass Field Day
 06/27/08 News 10 Now
 June 2008 Grassroots
 05/21/08 Empire State Farmer
 05/19/08 Country Folks
 05/15/08 American Agriculturist
 05/14/08 Hay & Forage Grower
 09/17/07 Country Folks
 09/17/07 renewablenergyaccess.com
 09/05/07 Cornell Chronicle
 08/31/07 Lowville Journal
 August 07 Absolutely Business Magazine
 07/02/07 Country Folks: Belleville-Henderson trials
 July 2007 Cornell Cooperative Extension of Jefferson County Ag News

06/20/07 Empire State Farmer: St. Lawrence County trials
06/17/07 TV 7 WWNY TV 6 and 11 pm News: St. Lawrence County trials
06/15/07 Farmer's Friend
06/14/07 Watertown Times: St. Lawrence County trials
06/13/07 News 10 Now: St. Lawrence County trials
June 2007 Cornell Cooperative Extension News
06/11/07 Country Folks: St. Lawrence County trials
06/11/07 NY Farm Bureau requested info and photos
06/11/07 Jefferson County Ag News Flash
03/26/07 Watertown Times: Belleville-Henderson trials

Press Releases

The following press releases, issued by the Northern New York Agricultural Development Program and the NY Farm Viability Institute, put a spotlight on grass research in NNY.

May 10, 2008

Grass for Energy Research Expanded in NNY

February 15, 2008

NNY Agricultural Development Program Announces 22 Grant Projects for 2008

June 11, 2007

North Country Farmers Switching to Grass as Energy, Livestock Feed Crop

May 30, 2007

Evaluating Grasses as Bioenergy Crops: New Plantings at Belleville-Henderson School Among Those In & Planned for NNY