NNY Agricultural Development Program
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Evaluation of Warm Season Grasses for Biofuel Production in Northern NY

Project Leader(s):
D.R. Viands, Department of Plant Breeding and Genetics
J. Hansen, Department of Plant Breeding and Genetics
H. Mayton, Department of Plant Breeding and Genetics

Collaborator(s):
Gary Bergstrom, Russ Hahn, Quirine Ketterings, Elson Shields, Mike Davis (W.H. Miner Agricultural Research Institute), Pete Barney (St. Lawrence Co. Extension), Anita Deming (Essex Co. Extension), Paul Salon (USDA Big Flats Plant Materials Center, Corning, NY), Mike Hunter (Jefferson Co. Extension), Steve Jones (Bellevue Central School District).

Cooperating Producers: 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 primary bioenergy crop used for ethanol production in the US, but perennial grasses have the potential to be more economical and environmentally sustainable than corn for ethanol production. The cellulosic conversion process that produces ethanol from biomass utilizes a greater percentage of the plant than the corn-ethanol conversion process. Corn is an annual crop and requires substantial inputs each planting year, whereas the grasses identified as candidates for dedicated bioenergy crops are perennials and can be harvested for several years with very little input. Perennial grasses can be used for conversion to liquid fuels or for direct combustion. Life cycle analyses of perennial grasses have demonstrated that these crops will reduce greenhouse gas emissions when used as an alternative to fossil fuels. In addition, perennial grasses reduce soil erosion and improve soil health and structure 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 potential for high biomass production. 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. Therefore, data obtained in the Midwest trials may not reflect how different perennial grass species or varieties within species will perform in New York. The objectives of this project are to evaluate several switchgrass varieties along with other warm season grass species for biomass yield and bioenergy crop value.

Methods: A replicated perennial grass trial (144 total plots) was established in a field (Collamer silt loam soil type) adjacent to the Belleville Central School in Jefferson County, NY (Figures 1 and 2). A few weeks prior to planting the field, an annual ryegrass cover crop was sprayed with the herbicide Roundup® (Monsanto, St. Louis, IL). The field was prepared for planting by mold-board plowing, disking, rototilling, and smoothing with a Brillion seeder (Brillion Iron Works Inc., Brillion, WI, Figure 3). Plots (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 different trial entries (Table 1) was planted with a Carter (Carter Manufacturing Co., Brookston, ID) small plot seeder. Twenty trial entries were planted in monoculture (a single variety of a grass species) and four entries consisted of a mixture of two different grass species. After planting, the field trial was cultipacked to enhance seed to soil contact.

Seeding rate for switchgrass and eastern gamagrass was 10 lb pure live seed (PLS)/A; big bluestem 12 lb PLS/A; and coastal panicgrass 8 lb PLS/A (Table 2). Pure live seed is the percentage of seed that is alive, and percent quick germination is the percent of seeds that will germinate shortly after planting, the remainder of the seed is dormant or dead. The actual seeding rate per variety was corrected for percent pure live seed and percent quick germination reported on the seed tag label by the companies from which seed was obtained (Table 2). The approximate number of pure live seeds per monoculture plot ranged from 274 for eastern gamagrass to 19,493 for 'Pathfinder' switchgrass. This range is due to variation in seed size and percent quick germination among the seed lots. After correcting the seeding rate for the percent quick germination rate, the actual seeding rate ranged from 9 to 63 lbs/A (Table 2). Thus for research purposes, the number of seeds per plot was standardized across all seed lots. For this short term research project, it was necessary to have the same number of germinable seeds planted per plot to collect adequate data on stand counts. Producers would not normally correct for percent quick germination because some of the dormant seed should germinate. Since seed of warm-season grasses is expensive, it is important for producers to try to purchase seed lots with high percent pure live seed and high percent quick germ to keep input seed costs as low as possible. This is an area that needs further research in order to determine and make recommendations for the most appropriate seeding rate for planting.

During the seeding year, data were collected on percent stand established and canopy height. Plant disease incidence and severity, weed pressure, and seedling vigor were also recorded. Because it takes three years to establish a mature stand of the warm season grasses selected for the trial, yield and cell wall composition of the trial entries and quality characteristics important for conversion to biofuels will begin to be evaluated in 2008. Weeds were cut once during the growing season in July with a string trimmer. After planting, fertilizer or pesticides were not applied in order to minimize total input costs.

Results: Researchers have reported that a grass stand of approximately 40% in the establishment year was a good indication of a successful planting. By this criterion, all of the grass species/varieties had acceptable establishment except for 'Niagara' big bluestem and 'Pete' eastern gamagrass. The average percent stand of all grass entries planted in Jefferson County in 2007 was 62 %. The switchgrass varieties 'Blackwell', 'Carthage', 'Shelter', 'Forestburg', and 'Cave-in-rock' had the highest 1st year stands (Table 3).

These data are consistent with stand establishment data from other warm season grass trials planted at various locations in New York State in 2007. Big bluestem cultivars 'Goldmine' and Niagara and other warm season grass species did not establish as well as the majority of switchgrass cultivars. The seed for the switchgrass cultivar Pathfinder was heavily contaminated with foxtail weed seeds and thus we were unable to collect data on stand establishment (Table 3).

In terms of overall growth measured by canopy height, the switchgrass cultivars Blackwell, Carthage and Cave-in-rock performed well. Significant weed pressure was observed in the plots (Figure 4); however, the warm season grass plants apparently were still able to receive adequate sunlight and moisture and were not smothered by the weeds. The most common broadleaf weeds observed in the plots were pigweed, lamb's quarter, and ragweed. Other weeds present were foxtail, and nutsedge. Leaf spot disease symptoms were observed on most varieties but did not exceed more than 10 % in any individual grass plot.

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. Establishment of the warm season perennial grasses without the use of post-emergent herbicide applications resulted in plots with heavy weed pressure (Figure 4), yet good stands of the grasses were obtained in most cases when good quality seed was planted. All of the plots in each replicate had at least 40% weed infestation. 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. Data collected in 2008 will provide more information on stand, weed pressure, cultivar biomass yields and bioenergy quality characteristics.

Outreach: Information regarding the trial was reported at field days held in Tompkins County, at the USDA/NRCS Plant Materials Center in Big Flats, and in Dutchess County. 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 2007. Several field day meetings will be held during the 2008 field season.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education. Yield data of the various perennial grasses harvested from the plot trials and characteristics associated with energy conversion will be evaluated in 2008. An additional small plot trial identical to the experiment in Jefferson county will be established at the W.H. Miner Agricultural Research Institute in 2008.

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Reports and/or articles in which results of this project have already been published. These data will be included in fact sheets, information packages, reports and articles associated with perennial grass biofuel projects currently underway at Cornell University. They also will be available on a web site that is being created.

For more information:

Hilary Mayton hsm1@cornell.edu; Julie Hansen jlh17@cornell.edu; and Donald Viands drv3@cornell.edu; Cornell University; Department of Plant Breeding and Genetics; 523 Bradfield Hall; Ithaca, NY 14853-1902. 607-255-5043; http://plbrgen.cals.cornell.edu/people/profiles/viandsdonald.cfm

Appendices:

Table 1. Common name and scientific name of grasses planted.

Common name	Species
big bluestem	*Andropogon gerardii*
coastal panic grass	*Panicum amarulum*
eastern gamagrass	*Tripsacum dactyloides*
indiangrass	*Sorghastrum nutans*
switchgrass	*Panicum vergatum*

Table 2. Variety, common name and species along with % pure live seed (PLS), % quick germination, and seeding rate of perennial grass entries in Jefferson County cultivar evaluation trial.

Entry	Variety	Common name	% PLS*	% Seed tag quick germination	Seeding Rate lb PLS/A	Actual** Seeding Rate lb/A
1	Bonanza	big bluestem	72	80	12	15
2	Goldmine	big bluestem	56	68	12	18
3	Niagara	big bluestem	22	74	12	16
4	Atlantic	Coastal panic grass	87	88	8	9
5	Pete	eastern gamagrass	84	30	10	33
6	Blackwell	switchgrass	86	31	10	32
7	Carthage	switchgrass	94	51	10	20
8	Cave-in-rock	switchgrass	95	71	10	14
9	Cave-in-rock***	switchgrass	95	37	10	27
10	Forestburg	switchgrass	77	21	10	48
11	Kanlow	switchgrass	93	86	10	12
12	Pathfinder	switchgrass	74	16	10	63
13	Shawnee	switchgrass	93	93	10	11
14	Shelter	switchgrass	86	22	10	45
15	Sunburst	switchgrass	98	98	10	10
16	Trailblazer	switchgrass	93	83	10	12
17	Nebraska 54	indiangrass	92	67	10	15
18	Nebraska 28	switchgrass	92	92	10	11
19	Rumsey	indiangrass	86	78	10	13
20	Pawnee	big bluestem	63	68	12	18
21	Cave-in-Rock	switchgrass	95	37	5	14
	Bonanza	big bluestem	72	80	6	8
22	Sunburst	switchgrass	98	98	5	5
	Niagara	big bluestem	22	74	6	8
23	Cave-in-rock	switchgrass	95	37	5	14
	Pete	eastern gamagrass	84	30	5	17
24	Niagara	big bluestem	22	74	6	8
	Pete	eastern gamagrass	84	30	5	17

* % 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. Data of percent stand established and canopy height of perennial warm season grasses from the 2007 field season from the small plot trial established in Jefferson County, NY.

Entry	Variety	Common name	% Stand 9/5/07	Height (inches) 9/5/07
9	Cave-in-rock*	switchgrass	83	30
14	Shelter	switchgrass	83	25
7	Carthage	switchgrass	81	30
6	Blackwell	switchgrass	80	35
1	Bonanza	big bluestem	77	26
13	Shawnee	switchgrass	75	28
10	Forestburg	switchgrass	70	23
16	Trailblazer	switchgrass	70	35
18	Nebraska 28	switchgrass	70	21
11	Kanlow	switchgrass	68	25
15	Sunburst	switchgrass	62	24
20	Pawnee	big bluestem	62	26
8	Cave-in-rock	switchgrass	60	30
2	Goldmine	big bluestem	57	16
19	Rumsey	indiangrass	57	19
17	Nebraska 54	indiangrass	48	22
4	Atlantic	coastal panic grass	43	29
3	Niagara	big bluestem	32	20
5	Pete	eastern gamagrass	19	19
12	Pathfinder	switchgrass	.	.
21	Cave-in-Rock	switchgrass	62	28
	Bonanza	big bluestem	62	22
22	Sunburst	switchgrass	43	34
	Niagara	big bluestem	43	26
23	Cave-in-Rock	switchgrass	70	36
	Pete	eastern gamagrass	70	19
24	Niagara	big bluestem	65	10
	Pete	eastern gamagrass	65	10

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