

Development of Inbreds, Hybrids, and Enhanced GEM Breeding Populations with Superior Silage Yield and Nutritional Value

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Overview: Approximately 8% (2,500,000 ha) of all corn harvested in the USA is harvested as silage that is fed to ruminants. Most of the silage corn is grown in the northern Corn Belt and the northeastern U.S., where the percentage silage can be as high as 50%. New hybrids are now routinely screened for silage potential in several states including Wisconsin, Michigan, and New York because the quality differences among hybrids can have economic consequences for milk and beef production. The GEM project has potential for bringing new germplasm into the Corn Belt with excellent grain and silage yield, as well as improved nutritive value.

In 2006, we continued to evaluate silage yield and nutritive value of the most productive GEM crosses identified in grain yield evaluations conducted over the past several years by the GEM project. These hybrids are chosen annually based on maturity and excellent grain yield in GEM evaluations conducted in previous years throughout the U.S. Corn Belt. If any of these crosses have high dry matter yield and good nutritional quality in our UW trials, the respective GEM parent or breeding population is included in the UW inbred development nursery for further inbreeding and selection. The 2006 trials include a combination of new GEM hybrids and advanced-generation inbred testing of GEM materials.

2006 Field Trials:

Trial GEMNEW consisted of the silage evaluation of elite GEM topcrosses that were identified in the past year as having high grain yield and suitable maturity ($\leq 120\text{RM}$) for Wisconsin. GEMNEW included 23 S2+ GEM inbreds crossed to HC33, LH198, or LH287, and six hybrid checks (Table 1).

Trial GQS604S represents our new breeding effort for the GEM Quality Synthetic (GQS), developed from GEM breeding populations CUBA164:S1517, CUBA164:S15, and CUBA117:S1520. GQS is approximately 75% Stiff Stalk, and we intend to create inbred lines from GQS that produce silage hybrids with high forage yield as well as superior nutritional quality when crossed to inbred lines from our Wisconsin Quality Synthetic (WQS), which is a non-Stiff Stalk breeding population. We are using the same S2-testcross breeding system used for WQS. In 2005, we visually screened approximately 200 S1 GQS families in the nursery and in a separate stress trial. We crossed the surviving S2 families (73) to inbred W604S in our 2005/6 winter nursery. These crosses were evaluated for silage potential in 2006 (Table 2).

Trial M244332 included hybrids involving three advanced inbred lines from the GEM program (CHO5015:N15-8-1-B-B-22-1-1, SCRO1:N1310-398-1-B-21-1-1-B, and SCRO1:N1310-398-1-B-21-1-2-B) each crossed to three testers (LH227, LH244, and LH332), along with four check hybrids (Table 3). The GEM inbred lines have performed well in past years and one or more may be released in the future.

The three trials were planted at two WI locations, Madison (May 21) and Arlington (June 2). GEMNEW and M244332 had three replications at each location, and GQS604S had two replications at each location. The average planting densities ranged from 28,600 to 32,800 plants/acre. There were extreme winds early in the season, which badly damaged both the Madison and Arlington trials. The GEMNEW and M244332 trials at Arlington were eventually abandoned due to extreme lodging coupled with a mechanical failure of our JD5200 forage harvester. However, lodging scores were recorded at both locations. The Madison trials were harvested in mid-September. The Arlington trials were harvested in early October. For a detailed description of these trials see <http://www.silagebreeding.agronomy.wisc.edu>.

Nutritional evaluations are not yet completed. Nutritional evaluations will include assessment of neutral detergent fiber (NDF), in vitro true digestibility (IVD), in vitro NDF digestibility (IVNDFD), crude protein (CP), and starch concentration. Based on these values, milk/ton of forage and milk/acre will be estimated based on MILK2006, which uses forage composition (NDF, IVD, IVNDFD, CP, and starch) to estimate potential milk production per ton of forage. Forage yield is then used to estimate potential milk per acre. Nutritional evaluation will be completed in approximately one month and the results posted on our web site.

GEMNEW highlights: Of the 23 new GEM topcrosses, the forage yield of 15 exceeded 9.92 tons/acre, which was average of the four check hybrids (Table 1). Of these 15, five were suitable for southern Wisconsin environments, based on dry matter > 35% and moderate to low lodging scores. One of these (GUAT209:S1308a-084 -001 X LH287) had forage yield greater than 11 tons/acre. Note also the high forage yield of W605S X LH244 (11.15 tons/acre). W605S, which was released in 2004, was developed from the GEM breeding population AR17026:N1019. Unfortunately, the yield data in Table 1 represent only the Madison location due to abandonment of the Arlington site.

GQS604S highlights: Of the 73 hybrids with inbred W604S, 41 were chosen for nutritional evaluation (Table 2). On average, the forage yield of these was lower than the check hybrids, although there were a few hybrids that exceeded 9 tons/acre. W604S may be poorly suited as a tester for GQS, and additional testers will be used for subsequent inbred generations. The nutritional properties of the hybrids will likely be more encouraging, and it is also likely that additional cycles of breeding may improve the combining ability of inbred lines from GQS with those from WQS.

M244332 highlights: The GEM inbred lines have good yield potential and, when crossed to earlier-maturing testers such as LH227, and perhaps LH332, are suitable for southern Wisconsin. The low lodging scores for CHO5015:N15-8-1-B-B-22-1-1 hybrids were especially noteworthy. We will evaluate release of these inbred lines after reviewing the nutritional properties later this winter.

2006 Nursery Activities:

In our breeding nursery, approximately 200 GEM families were further inbred, and approximately 100 promising S4+ lines will be crossed to inbred testers, LH244, LH332 and W604S for 2007 evaluations. These lines were derived from breeding crosses AR16026:S1719, AR17056:N2025 BR52051:N04, CHO5015:N15, CUBA164:2012, DK212T:N11a12, FS8B(T):N11a, and SCRO1:N1310. We also added several new GEM inbred bulks to our

nursery in 2006 for inbred line development. These were FS8B(T):N11a-087-1-B-B-B and CHIS775:S1911b-143-1-B-B-B.

For additional information, all activities of the UW silage breeding program, including nurseries and yield trials, are available through our web site (<http://www.silagebreeding.agronomy.wisc.edu>).

Table 1. Forage yield evaluation for GEMNEW trial in 2006. Forage yield was evaluated at Madison, WI. Lodging scores (0 = no lodging) were evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality.

06No.	Entry	Dry matter %	Yield t/a	Lodge score 0-10	Quality evaluation
1	AR17026:S1612-075-001 X LH287	36.3	10.39	5.0	*
2	DK888:N11a08a-102-001 X LH198	36.0	8.47	6.2	
3	DK888:N11a08a-112-001 X LH198	35.4	7.39	7.8	
4	DK888:N11a08a-125-001 X LH198	37.2	10.07	4.2	
5	DK888:N11a08a-140-001 X LH198	33.6	9.27	6.2	
6	DK888:N11a08a-190-001 X LH198	34.6	11.02	2.8	*
7	DK888:N11a08a-218-001 X LH198	33.0	9.54	4.5	
8	DK888:N11a08a-344-001 X LH198	32.8	9.61	4.0	
9	DK888:N11a08a-408-001 X LH198	33.4	10.82	3.8	*
10	DK888:N11a08a-428-001 X LH198	34.5	10.33	2.8	*
11	DK888:N11a08a-440-001 X LH198	32.4	12.21	2.0	*
12	DK888:N11a08a-462-001 X LH198	36.4	8.90	6.3	
13	DK888:N11a08a-537-001 X LH198	34.0	10.88	4.2	*
14	FS8B(T):N11a08b-310-001 X LH198	35.6	10.55	4.7	*
15	FS8B(T):N11a08c-144-001 X HC33	32.7	9.47	3.0	
16	FS8B(T):N11a08c-144-002 X HC33	35.0	10.55	1.7	*
17	GUAT209:S1308a-013 -001 X LH287	32.6	11.68	4.2	*
18	GUAT209:S1308a-047 -001 X LH287	34.0	8.40	4.2	
19	GUAT209:S1308a-067 -001 X LH287	34.1	10.67	4.3	*
20	GUAT209:S1308a-084 -001 X LH287	36.2	11.24	4.0	*
21	GUAT209:S1308a-135 -001 X LH287	32.4	11.90	3.3	*
22	GUAT209:S1308a-137 -001 X LH287	33.3	10.48	4.3	*
23	GUAT209:S1308a-149 -001 X LH287	34.7	10.34	5.3	*
24	W604S X LH244 (check hybrid)	40.2	8.64	3.5	*
25	W605S X LH244 (check hybrid)	34.7	11.15	4.7	*
26	WQS C3 X GQS C0	35.7	8.43	5.0	*
27	LH244 X LH287 (check hybrid)	33.4	10.37	3.7	*
28	P34N44 (check hybrid)	37.5	9.54	4.0	*
29	N48V8 (leafy)	39.3	10.51	6.3	*
30	F697 (bm3)	30.5	5.31	5.5	*
	Mean	34.7	9.94	4.4	
	CV (%)	3.9	11.6	38.2	
	LSD (0.05)	2.2	1.88	3.1	

Table 2. Forage yield evaluation for GQS604S trial in 2006. Forage yield and lodging scores (0 = no lodging) were evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality.

06No.	Entry	Dry matter	Yield	Lodge score	Quality evaluation
		%	t/a	0-10	
1	50008-1 X W604S	38.5	7.54	2.8	*
2	50011-1 X W604S	38.9	6.90	1.3	
3	50011-2 X W604S	37.7	5.57	4.3	
4	50012-1 X W604S	37.3	6.38	4.8	
5	50012-2 X W604S	38.3	6.18	6.7	
6	50014-1 X W604S	38.5	7.52	2.8	*
7	50014-2 X W604S	39.3	7.37	1.3	
8	50015-1 X W604S	37.8	6.43	3.8	
9	50015-2 X W604S	37.4	6.64	2.8	
10	50021-1 X W604S	40.4	8.92	1.5	*
11	50024-1 X W604S	34.8	5.72	4.0	
12	50025-1 X W604S	40.2	7.84	2.8	
13	50025-2 X W604S	43.6	7.02	1.4	
14	50027-1 X W604S	40.6	7.87	3.3	*
15	50028-1 X W604S	40.9	7.45	2.3	
16	50029-1 X W604S	41.7	7.51	2.0	
17	50031-1 X W604S	39.6	7.17	4.5	
18	50032-1 X W604S	38.3	8.44	2.0	*
19	50035-1 X W604S	38.2	7.68	3.3	
20	50035-2 X W604S	39.3	8.48	3.8	*
21	50036-1 X W604S	40.3	6.38	2.8	
22	50036-2 X W604S	41.2	8.69	2.4	*
23	50038-1 X W604S	37.6	8.22	1.8	*
24	50043-1 X W604S	41.0	7.31	3.3	
25	50046-1 X W604S	37.3	6.76	3.8	
26	50047-1 X W604S	42.5	7.34	3.0	
27	50048-1 X W604S	38.6	7.43	2.8	
28	50059-1 X W604S	37.9	8.83	1.0	*
29	50060-1 X W604S	41.1	8.25	3.0	*
30	50061-1 X W604S	37.2	6.51	1.8	
31	50063-1 X W604S	34.5	8.19	4.0	*
32	50065-1 X W604S	36.9	7.99	1.8	*
33	50067-1 X W604S	36.3	7.25	2.3	
34	50072-1 X W604S	37.6	9.20	3.0	*
35	50076-1 X W604S	38.6	7.43	2.8	
36	50081-1 X W604S	38.3	8.03	3.0	*
37	50082-1 X W604S	37.8	7.22	5.3	
38	50090-1 X W604S	39.2	6.92	3.0	
39	50093-1 X W604S	38.6	8.27	3.8	*
40	50094-1 X W604S	40.5	8.80	1.8	*
41	50100-1 X W604S	36.3	7.66	2.8	
42	50103-1 X W604S	35.6	8.39	4.0	*
43	50114-1 X W604S	37.6	9.36	1.8	*

44	50116-1 X W604S	34.8	7.05	1.8	
45	50117-1 X W604S	37.3	8.72	0.7	*
46	50118-1 X W604S	36.1	8.57	2.3	*
47	50119-1 X W604S	37.1	8.04	1.7	*
48	50120-1 X W604S	40.4	8.63	0.7	*
49	50127-1 X W604S	41.3	8.45	0.8	*
50	50137-1 X W604S	36.8	8.27	1.7	*
51	50138-1 X W604S	38.8	7.56	2.7	
52	50139-1 X W604S	37.3	7.58	2.5	*
53	50142-1 X W604S	37.4	7.30	1.0	
54	50148-1 X W604S	40.5	8.68	1.7	*
55	50148-2 X W604S	38.8	7.45	2.3	
56	50156-1 X W604S	38.8	8.73	1.8	*
57	50157-1 X W604S	37.9	8.31	3.3	*
58	50159-1 X W604S	37.6	8.71	1.7	*
59	50160-1 X W604S	36.1	8.41	0.8	*
60	50162-1 X W604S	34.3	8.06	1.5	*
61	50165-1 X W604S	35.6	8.25	2.3	*
62	50166-1 X W604S	35.9	8.00	1.8	*
63	50167-1 X W604S	38.9	7.61	1.7	
64	50169-1 X W604S	35.0	6.93	1.8	
65	50174-1 X W604S	38.0	7.68	2.0	*
66	50179-1 X W604S	36.7	8.86	0.8	*
67	50189-1 X W604S	38.4	8.64	2.8	*
68	50194-1 X W604S	36.7	8.84	1.7	*
69	50196-1 X W604S	36.6	8.39	1.8	*
70	50197-1 X W604S	37.9	8.73	4.8	*
71	50198-1 X W604S	37.2	7.26	3.8	
72	50199-1 X W604S	42.2	7.92	2.8	*
73	50200-1 X W604S	37.1	8.63	2.0	*
74	W604S X LH244 (check hybrid)	36.6	9.80	3.0	*
75	W605S X LH244 (check hybrid)	35.0	9.59	5.3	*
76	LH244 X LH287 (check hybrid)	36.2	9.47	3.0	*
77	P34N44 (check hybrid)	40.3	9.34	4.0	*
78	F697 (bm3)	30.1	5.37	6.5	*
	Mean	38.1	7.86	2.7	
	CV (%)	4.8	13.1	59.6	
	LSD (0.05)	2.5	1.44	2.2	
	Mean of all GQS testcrosses	38.2	7.80	2.5	
	Mean of experimental entries (41) for quality evaluation	38.0	8.39	2.2	
	Mean of four check hybrids	37.0	9.55	3.8	

Table 3. Forage yield evaluation for M244332 trial in 2006. Forage yield was evaluated at Madison, WI. Lodging scores (0 = no lodging) were evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality.

06No.	Entry	Dry matter %	Yield t/a	Lodge score 0-10	Quality evaluation
48	CHO5015:N15-8-1-B-B-22-1-1 X LH227	35.9	10.58	1.0	*
49	CHO5015:N15-8-1-B-B-22-1-1 X LH244	32.9	10.13	0.7	*
50	CHO5015:N15-8-1-B-B-22-1-1 X LH332	35.1	9.56	1.7	*
51	SCRO1:N1310-398-1-B-21-1-1-B X LH227	39.8	11.61	4.8	*
52	SCRO1:N1310-398-1-B-21-1-1-B X LH244	34.1	11.35	4.3	*
53	SCRO1:N1310-398-1-B-21-1-1-B X LH332	36.4	10.34	5.8	*
54	SCRO1:N1310-398-1-B-21-1-2-B X LH227	38.3	9.29	5.2	*
55	SCRO1:N1310-398-1-B-21-1-2-B X LH244	33.9	9.14	5.0	*
56	SCRO1:N1310-398-1-B-21-1-2-B X LH332	35.2	11.47	4.2	*
57	LH244 X LH287 (check hybrid)	32.7	10.31	4.0	*
58	W604S X LH244 (check hybrid)	38.1	8.64	4.0	*
59	W604S X LH332 (check hybrid)	36.8	10.53	2.2	*
60	P34B23 (check hybrid)	36.4	12.33	2.5	*
	Mean	35.7	9.62	4.0	
	CV (%)	3.6	11.8	41.6	
	LSD (0.05)	2.1	1.84	3.1	