

DEVELOPMENT OF MAIZE INBREDS, HYBRIDS, AND ENHANCED GEM BREEDING POPULATIONS FOR SUPERIOR SILAGE, BIOFEEDSTOCK YIELD, AND COMPOSITIONAL ATTRIBUTES

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Overview:

About 6.4% of the approximately 87 million acres of corn harvested in the U.S were dedicated to silage production in 2010. Of those, approximately 750,000 acres were located in Wisconsin, the largest silage producing state in the U.S. (USDA, 2011).

Given the importance of silage in the state of Wisconsin, the Corn Silage Breeding program at the University of Wisconsin (UW) was initiated in the early 1990's with the goal of realizing some of the potential benefits of improving forage quality to enhance both, the nutritional value and forage yield of corn for silage. This was the first breeding program in the U.S. focused on the development of corn varieties for biomass production, currently used for animal feed. A more substantial effort has been observed just recently in the private sector. The UW Corn Silage Breeding Program has been incorporating new sources of germplasm from the GEM project for a number of years as a means to enhance primarily forage yield but also compositional quality of the materials generated.

Parallels have been drawn between the biomass quality properties of corn required for animal nutrition and those thought to be desirable for corn to be used as a feedstock for energy bioconversion. Therefore, the high forage yield and highly fermentable cell wall carbohydrate composition of the populations and crosses involving germplasm developed by the UW Corn Silage Breeding Program have shown promise for developing lignocellulosic biofeedstocks for ethanol production.

In 2011 The UW Corn Silage Breeding Program 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 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 2011 trials focused primarily on re-testing of different GEM materials and first evaluation of GEM populations 06GEM05390 and DKXL212.

2011 Field Trials:

Five trials involving GEM materials (AR16026, DK2888, DKXL212, GEM01834 and GEMS05390) were planted in 2011 at two WI locations, Madison (May 27th) and Arlington (May 24th). Trials were planted in triplicates in each of the locations with an average planting density of 32,800

plants/acre. Temperatures throughout the spring were around average for our area. High temperatures were observed around pollination time. Strong winds and heavy rain hit the Arlington station on July 11th causing substantial lodging in some sections of the field. For trial DK2888, advancement decisions were done using primarily the West Madison yield and dry matter data.

AR16026

Trial **AR16026** consisted of the silage re-evaluation of seven advanced inbred lines from the GEM program derived from the AR16026:S1719-052-2-B-B-B population testcrossed by Holdens tester LH287. Two of the experimental lines was also crossed by UW line W604S. Ten different hybrids (including commercial and internal) were also included as checks (Table 1).

AR16026 highlights (Table 1): This is a re-test from a 2010 trial evaluation. With the exception of one experimental cross by W604S, all AR16026 hybrids substantially exceeded the average yield of the checks excluding F2F633 (8.6 tons/acre). Dry matter content was a bit above ideal (41.8%) for this trial. Quality evaluation will be performed for all crosses by LH287 and one of the two available crosses by W604S. After quality evaluation analysis is completed, decisions will be made as to which lines from AR16026 might be publicly released.

DK2888

Trial **DK2888** consisted of the silage evaluation of 11 advanced experimental inbred lines from the GEM program derived from DK888:N11a08a:440-001-B crossed to Holdens' testers LH244 and LH332. Ten different hybrids (including commercial and internal) were also included as checks (Table 2). Due to severe lodging observed at the Arlington location, only data from the West Madison location was analyzed and evaluated for advancement decisions.

DK2888 highlights (Table 2): The average forage yield of the DK2888 experimental hybrids was 9.5 tons/acre. Of the 16 DK2888 experimental hybrids evaluated, the forage yield of ten DK2888 hybrids exceeded the average of the trial checks excluding F2F633 (9.1 tons/acre). Dry matter content was ~4% points lower than the checks, but still within the desirable range. Quality evaluation will be performed for ten of the 16 hybrids evaluated for yield in this trial to determine merit for public release.

DKXL212

Trial **DKXL212** consisted of the first silage evaluation of 19 experimental inbred lines from the GEM program derived from the DKXL212:S0912-117-001 population testcrossed by UW line tester W604S. Eleven different hybrids (including commercial and internal) were also included as checks (Table 3).

DKXL212 highlights (Table 3): Of the 19 hybrids evaluated, the forage yield of only one of those crosses exceeded the average yield of the trial's checks excluding F2F633 (8.9 tons/acre). Dry matter content was within the range observed for the checks. Quality evaluation will be performed for three of the 19 hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from DKXL212, if any, will be further advanced.

GEM01834

Trial **GEM01834** consisted of the second silage evaluation of seven experimental inbred lines from the GEM0183 population and one experimental inbred line from the GEM population GEM0184 testcrossed by Holdens tester LH287. Ten different hybrids (including commercial and internal) were also included as checks (Table 4).

GEM01834 highlights (Table 4): Of the eight hybrids evaluated, the forage yield of five of those crosses exceeded the average yield of the checks excluding F2F633 (8.6 tons/acre). Dry matter content was 5% units below the average of the checks. Quality evaluation will be performed for five of the eight hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from GEM0183 and/or GEM0184 will be further advanced.

GEMS05390

Trial **GEMS05390** consisted of the first silage evaluation of 22 experimental inbred lines derived from the GEMS05390 population testcrossed by Holdens tester LH287. Ten different hybrids (including commercial and internal) were also included as checks (Table 5).

GEMS05390 highlights (Table 5): Of the 22 GEMS05390 hybrids evaluated, the forage yield of six of those crosses exceeded the average yield of the trial (8.6 tons/acre) and only two of them exceeded the average of the checks excluding F2F633 (9.3 tons/acre). Dry matter content of the experimental crosses was ~3.5% points higher than the mean of the checks. Quality evaluation will be performed for eight of the 22 hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from GEMS05390 will be further advanced.

Nutritional evaluations will include assessment of neutral detergent fiber (NDF), *in vitro* true digestibility (IVTD), *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, IVTD, IVNDFD, CP, and starch) to estimate potential milk production per ton of forage. Forage yield is then used to estimate potential milk per acre.

2011 Nursery Activities:

The breeding population GQS is being advanced using a second generation (S_2) top-cross selection method. Briefly, inbreds derived from succeeding cycles of improvement are developed and released. Population improvement and inbred development occur simultaneously. S_2 families derived from GQS are initially screened for general agronomic adequacy and are then top-crossed to elite commercial lines from complementary heterotic groups during the following year. The following summer, top-crosses are grown to estimate forage yield and quality of whole-plant compositional characteristics such as fiber, digestibility, protein, and starch at silage harvesting time. Twenty S_2 families are selected based on a performance index (MILK2006) that comprises silage yield and compositional quality.

During summer 2007 the top 20 selected families from Cycle 0 (GQS C0) of this population were recombined to give rise to GQS C1. During the winter nursery of 2007/8 20 GQS HS families derived from the intermating process conducted in summer 2007 were sent to our winter nursery in Puerto Rico for selfing. At least 20 self-pollinations were conducted for each of the HS families. Ten S_1 families were derived from each of the 20 HS families. These approximately 200 S_1 families were planted in our summer nursery 2008. Later that summer about half of these S_1 families were eliminated based on agronomic appearance. Three to four self-pollinations were done in each row, but only two ears were harvested from each row at the end of the season. This produced a total of 200 S_2 lines. These 200 S_2 lines were testcrossed in 2009 by inbred line W604S. A set of 201 lines were evaluated in a replicated trial at two locations (Madison and Arlington, WI) with two replications per location in 2010. A set of the 39 highest forage yielding lines from this trial were analyzed for quality composition. The best 20 S_2 lines based on the quality evaluation were recombined to form cycle 2 of the GQS population (GQS C2) during summer 2011. In addition to that, two S_3 lines were derived from 33 of the 36 highest forage yielding S_2 lines (the other three - 81040-1, 81093-1 and 81157-1 - only included one S_3 representative) and were sent to our 2010/11 winter nursery to be crossed by W604S. Not enough seed was obtained from many of those crosses, so they were attempted again in our 2011 summer nursery. The complete set of S_3 testcross evaluation of the GQS C1 is scheduled to occur in 2012.

In our 2011 breeding nursery, populations GEMN-0186 and GEMS-0185 continue to be selfed for advancement. Since these are waxy conversions, they will be used as testers for each other and evaluated after they are crossed in 2012. Seven additional GEM families GEMS-0199, GEMS-0200, GEMS-0201, GEMS-0202, GEMS-0203, GEMS-0204, and GEMS-0205 (AR16021:S0908a-039-001-B-B, BR105:S1612-008-001-B-B, BR105:S1612-057-001-B-B, BR105:S1640-128-001-B-B, CUBA164:S2008dF44-012-001-B-B, FS8A(T):N1804-006-001-B-B and GUAD05:N3215-197-001-B-B, respectively) were self-pollinated for further advancement and crossed by W612S for first evaluation in 2012.

Advanced inbreds from families PASCO14:N0424-078-001-B-B (GEMN-0190), SCROGP3:N2017-003-001 (GEMN-0191), SCROGP3:N2017-172-001 (GEMN-0192), UR11002:N0308b-086-001 (GEMN-0193), DKXL212:S0912-012-001 (GEMS-0188), DKXL212:S0912-117-001 (GEMS-0189) were sent to winter nursery 2010-11 for further advancement and to cross. Not enough seed was obtained from the crosses, so they were attempted again in our 2011 summer nursery for

evaluation in 2012. In addition to that a set of six new GEM populations (GEMS-0218, GEMS-0219, GEMS-0220, GEMN-0221, GEMS-0222, and GEMS-0223) were introduced to our summer nursery in 2011 for first selfing.

Table 1. Forage yield evaluation for AR16026 trial in 2011. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

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Table 2. Forage yield evaluation for DK2888 trial in 2011. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2011 EXPT DK2888		Madison			For Quality Evaluation
11No.	Entry	Dry matter	Lodging	Yield	
		%	1 - 10	t/a	
1	DK2888:N11a08a:440-001-B-9-2-1 X LH332	41.5	0.0	9.5	*
2	DK2888:N11a08a:440-001-B-9-2-1 X LH244	34.6	0.0	7.5	
3	DK2888:N11a08a:440-001-B-7-2-1 X LH244	40.5	0.0	10.9	*
4	DK2888:N11a08a:440-001-B-7-1-1 X LH332	40.6	0.0	8.5	
5	DK2888:N11a08a:440-001-B-7-1-1 X LH244	39.7	0.0	8.9	
6	DK2888:N11a08a:440-001-B-5-2-1 X LH244	36.4	0.0	8.4	
7	DK2888:N11a08a:440-001-B-19-2-1 X LH332	40.9	0.0	10.6	*
8	DK2888:N11a08a:440-001-B-17-2-1 X LH332	41.8	0.0	10.0	*
9	DK2888:N11a08a:440-001-B-17-2-1 X LH244	39.8	0.0	10.0	*
10	DK2888:N11a08a:440-001-B-17-1-2 X LH332	41.8	0.0	9.3	*
11	DK2888:N11a08a:440-001-B-17-1-2 X LH244	38.6	0.0	10.3	*
12	DK2888:N11a08a:440-001-B-15-2-2 X LH332	40.5	0.0	10.7	*
13	DK2888:N11a08a:440-001-B-14-1-1 X LH332	39.7	0.0	9.8	*
14	DK2888:N11a08a:440-001-B-12-2-1 X LH332	40.4	0.0	8.5	
15	DK2888:N11a08a:440-001-B-12-2-1 X LH244	33.5	0.0	7.7	
16	DK2888:N11a08a:440-001-B-11-1-2 X LH332	40.9	0.0	10.6	*
17	W604S X LH244	45.2	0.0	7.2	*
18	W605S X LH244	42.2	0.0	8.5	*
19	W612S X LH244	44.7	0.0	9.2	*
20	W606S X LH244	44.6	0.0	9.9	*
21	W607S X LH244	45.7	0.0	10.4	*
22	W609S X LH244	47.3	0.0	10.0	*
23	34A20	41.8	0.0	9.7	*
24	F2F633	40.7	0.0	8.6	*
25	N48V8	41.7	0.0	9.0	*
26	36H56	41.5	0.0	8.4	*
	Mean	41.0	0.0	9.3	✓
	CV (%)	6.0	.	16.4	
	LSD (0.05)	5.1	.	3.1	
	Mean of all DK2888 testcrosses	39.5	.	9.5	✓
	Mean of experimental entries for quality evaluation	40.6	.	10.2	✓
	Mean of checks (w/o F2633)	43.8	.	9.1	✓
Entries marked with "*" will be analyzed for nutritional quality					

Table 3. Forage yield evaluation for DKXL212 trial in 2011. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2011 EXPT DKXL212		Madison			Arlington			Mean			For Quality Evaluation
11No.	Entry	Dry matter	Lodging	Yield	Dry matter	Lodging	Yield	Dry matter	Lodging	Yield	
		%	1 - 10	t/a	%	1 - 10	t/a	%	1 - 10	t/a	
1	DKXL212:S0912-117-001-10 X W604S	46.1	0.0	7.8	.	.	.	39.7	0.0	6.3	
2	DKXL212:S0912-012-001-11 X W604S	43.2	0.0	5.3	36.2	.	7.4	39.7	0.0	6.3	
3	DKXL212:S0912-117-001-2 X W604S	43.5	0.0	7.3	35.1	.	7.0	39.3	0.0	7.2	
4	DKXL212:S0912-012-001-5 X W604S	45.1	0.0	7.7	35.1	.	8.4	40.1	0.0	8.1	
5	DKXL212:S0912-012-001-2 X W604S	45.0	0.0	5.8	36.3	.	7.3	40.6	0.0	6.5	
6	DKXL212:S0912-117-001-5 X W604S	44.6	0.0	8.9	35.4	.	7.8	40.0	0.0	8.4	*
7	DKXL212:S0912-012-001-1 X W604S	43.6	0.0	7.8	35.6	.	7.6	39.6	0.0	7.7	
8	DKXL212:S0912-012-001-9 X W604S	46.3	0.0	7.0	34.1	.	7.1	40.2	0.0	7.1	
9	DKXL212:S0912-117-001-3 X W604S	43.7	0.0	8.3	36.0	.	7.1	39.8	0.0	7.7	
10	DKXL212:S0912-012-001-10 X W604S	50.0	0.0	6.3	35.5	.	6.7	42.8	0.0	6.5	
11	DKXL212:S0912-012-001-8 X W604S	49.6	0.0	6.7	36.0	.	7.1	42.8	0.0	6.9	
12	DKXL212:S0912-117-001-1 X W604S	41.6	0.0	8.1	36.0	.	9.3	38.8	0.0	8.7	
13	DKXL212:S0912-012-001-6 X W604S	41.4	0.0	6.6	35.9	.	7.0	38.7	0.0	6.8	
14	DKXL212:S0912-117-001-6 X W604S	44.5	0.0	8.2	36.6	.	8.1	40.5	0.0	8.1	
15	DKXL212:S0912-012-001-7 X W604S	47.7	0.0	8.7	35.0	.	6.2	41.4	0.0	7.4	*
16	DKXL212:S0912-012-001-4 X W604S	48.1	0.0	7.4	35.7	.	7.8	41.9	0.0	7.6	
17	DKXL212:S0912-117-001-7 X W604S	43.0	0.0	7.4	34.8	.	8.1	38.9	0.0	7.8	
18	DKXL212:S0912-117-001-4 X W604S	42.3	0.0	7.6	37.3	.	8.5	39.8	0.0	8.1	
19	DKXL212:S0912-117-001-11 X W604S	43.4	0.0	9.0	35.2	.	9.1	39.3	0.0	9.0	*
20	W604S X LH244	44.6	0.0	8.0	31.4	.	6.2	38.0	0.0	7.1	*
21	W605S X LH244	44.3	0.0	8.8	31.8	.	6.7	38.0	0.0	7.8	*
22	W611s X LH244	45.8	0.0	9.0	34.3	.	9.1	40.1	0.0	9.1	*
23	W612S X LH244	44.4	0.0	8.4	35.4	.	9.5	39.9	0.0	9.0	*
24	W606S X LH244	43.4	0.0	9.6	36.3	.	8.9	39.8	0.0	9.2	*
25	W607S X LH244	44.0	0.0	9.6	34.0	.	10.0	39.0	0.0	9.8	*
26	W609S X LH244	47.6	0.0	8.6	34.0	.	7.7	40.8	0.0	8.1	*
27	34R67	45.4	0.0	11.0	37.5	.	10.4	41.5	0.0	10.7	*
28	F2F633	40.9	0.0	7.9	36.3	.	4.3	38.6	0.0	6.1	*
29	N48V8	45.5	0.0	8.4	36.9	.	10.1	41.2	0.0	9.3	*
30	36H56	42.9	0.0	8.8	34.9	.	8.9	38.9	0.0	8.9	*
	Mean	44.7	0.0	8.0	35.3	.	7.9	40.0	0.0	8.0	
	CV (%)	3.2		8.9	6.0		17.9	4.4	.	13.9	
	LSD (0.05)	2.4	.	1.2	4.4	.	2.9	3.3	.	1.3	
	Mean of all DKXL212 testcrosses	44.9	0.0	7.5	35.7	.	7.6	40.2	0.0	7.6	
	Mean of experimental entries for quality evaluation	44.5	.	7.7	35.4	.	7.7	40.2	.	7.7	
	Mean of checks (w/o F2633)	44.8	0.0	9.0	34.7	.	8.8	39.7	0.0	8.9	
	Entries marked with "*" will be analyzed for nutritional quality										

Table 4. Forage yield evaluation for GEM01834 trial in 2011. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2011 EXPT GEM01834		Madison			Arlington			Mean			For Quality Evaluation
11No.	Entry	Dry matter	Lodging	Yield	Dry matter	Lodging	Yield	Dry matter	Lodging	Yield	
		%	1 - 10	t/a	%	1 - 10	t/a	%	1 - 10	t/a	
1	GEMS-0183-14-2 X LH287	41.3	0.0	9.6	45.3	6.3	7.2	43.3	3.2	8.4	
2	GEMS-0183-2-1 X LH287	40.9	0.0	10.4	41.7	9.3	8.9	41.3	4.7	9.6	*
3	GEMS-0183-2-2 X LH287	42.3	0.0	10.4	44.2	9.3	8.8	43.2	4.7	9.6	*
4	GEMS-0183-4-1 X LH287	40.4	0.0	9.7	41.3	8.0	7.5	40.9	4.0	8.6	
5	GEMS-0183-4-2 X LH287	42.5	0.0	10.4	41.4	7.3	7.7	41.9	3.7	9.1	*
6	GEMS-0183-5-1 X LH287	39.6	0.0	9.4	40.0	7.3	8.5	39.8	3.7	9.0	*
7	GEMS-0183-5-2 X LH287	39.8	0.0	9.9	40.3	6.7	7.0	40.0	3.3	8.5	
8	GEMS-0184-6 X LH287	47.1	0.0	9.8	47.1	6.0	7.7	47.1	3.0	8.8	*
9	W604S X LH244	47.6	0.0	8.3	45.2	7.3	5.2	46.4	3.7	6.8	*
10	W605S X LH244	45.2	0.0	9.9	47.3	9.3	6.5	46.3	4.7	8.2	*
11	W612S X LH244	46.7	0.0	9.2	45.9	7.0	5.4	46.3	3.5	7.3	*
12	W606S X LH244	46.4	0.0	11.3	44.1	3.7	8.8	45.3	1.8	10.1	*
13	W610S X LH287	42.7	0.0	8.8	43.7	1.0	8.8	43.2	0.5	8.8	*
14	W609S X LH244	50.5	0.0	9.9	48.6	7.0	7.5	49.6	3.5	8.7	*
15	34A20	45.9	0.0	10.6	47.4	5.7	8.7	46.7	2.8	9.6	*
16	F2F633	38.2	0.0	8.1	39.7	9.3	4.4	38.9	4.7	6.3	*
17	N48V8	43.7	0.0	9.3	45.4	5.3	8.9	44.6	2.7	9.1	*
18	36H56	44.8	0.0	9.0	47.6	3.7	7.9	46.2	1.8	8.5	*
	Mean	43.6	.	9.7	44.2	6.6	7.5	43.9	3.3	8.6	
	CV (%)	3.6	.	7.7	4.3	39.7	23.6	4.0	56.1	15.9	
	LSD (0.05)	2.6	.	1.2	3.2	4.4	3.0	2.0	3.3	1.6	
	Mean of all GEM01834 testcrosses	41.7	0.0	10.0	42.7	7.5	7.9	42.2	3.8	8.9	
	Mean of experimental entries for quality evaluation	42.5	0.0	10.1	42.9	7.9	8.3	42.7	3.9	9.2	
	Mean of checks (w/o F2633)	46.0	0.0	9.6	46.2	5.6	7.5	46.1	2.8	8.6	
	Entries marked with "*" will be analyzed for nutritional quality										

Table 5. Forage yield evaluation for GEMS05390 trial in 2011. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with “*” will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2011 EXPt GEM50390											
		Madison			Arlington			Mean			For Quality Evaluation
11No.	Entry	Dry matter	Lodging	Yield	Dry matter	Lodging	Yield	Dry matter	Lodging	Yield	
		%	1 - 10	t/a	%	1 - 10	t/a	%	1 - 10	t/a	
1	06GEM05390-1-1 X LH287	48.6	0.0	8.0	36.8	0.0	6.9	42.7	0.0	7.5	
2	06GEM05390-1-2 X LH287	48.6	0.0	7.7	37.0	0.0	8.9	42.8	0.0	8.3	
3	06GEM05390-2-1 X LH287	48.1	0.0	9.5	36.5	0.0	8.4	42.3	0.0	8.9	*
4	06GEM05390-2-2 X LH287	51.1	0.0	9.3	39.6	0.0	9.1	45.3	0.0	9.2	*
5	06GEM05390-3-1 X LH287	47.3	0.0	8.7	37.0	0.0	10.3	42.1	0.0	9.5	*
6	06GEM05390-3-2 X LH287	45.8	0.0	9.1	36.6	0.0	8.0	41.2	0.0	8.6	*
7	06GEM05390-4-2 X LH287	47.9	0.0	7.6	36.2	0.0	6.9	42.1	0.0	7.3	
8	06GEM05390-5-1 X LH287	47.4	0.0	9.3	38.8	0.0	7.9	43.1	0.0	8.6	*
9	06GEM05390-5-2 X LH287	48.3	0.0	9.8	36.6	0.0	8.9	42.4	0.0	9.4	*
10	06GEM05390-6-1 X LH287	47.8	0.0	7.3	38.7	0.0	9.4	43.3	0.0	8.3	
11	06GEM05390-6-2 X LH287	50.4	0.0	8.2	36.5	0.0	8.8	43.5	0.0	8.5	
12	06GEM05390-7-1 X LH287	51.6	0.0	8.3	38.4	0.0	9.1	45.0	0.0	8.7	*
13	06GEM05390-7-2 X LH287	48.1	0.0	9.2	38.5	0.0	9.2	43.3	0.0	9.2	*
14	06GEM05390-8-1 X LH287	51.9	0.0	9.2	40.4	0.0	7.0	46.2	0.0	8.1	
15	06GEM05390-8-2 X LH287	51.1	0.0	9.0	38.7	0.0	7.8	44.9	0.0	8.4	
16	06GEM05390-11-1 X LH287	51.1	0.0	8.6	37.7	0.0	7.6	44.4	0.0	8.1	
17	06GEM05390-11-2 X LH287	48.6	0.0	8.5	36.6	0.0	7.8	42.6	0.0	8.2	
18	06GEM05390-12-1 X LH287	47.0	0.0	8.7	37.3	0.0	7.0	42.2	0.0	7.8	
19	06GEM05390-13-1 X LH287	46.0	0.0	8.2	35.2	0.0	8.6	40.6	0.0	8.4	
20	06GEM05390-13-2 X LH287	45.8	0.0	8.0	39.0	0.0	7.9	42.4	0.0	8.0	
21	06GEM05390-14-1 X LH287	53.6	0.0	8.4	37.8	0.0	8.6	45.7	0.0	8.5	
22	06GEM05390-14-2 X LH287	51.7	0.0	8.1	38.2	0.0	7.3	44.9	0.0	7.7	
23	W604S X LH244	48.8	0.0	8.3	37.2	0.0	7.2	43.0	0.0	7.8	*
24	W605S X LH244	45.5	0.0	9.1	34.7	0.0	9.7	40.1	0.0	9.4	*
25	W612S X LH244	48.8	0.0	9.0	-	-	-	-	-	-	*
26	W606S X LH244	46.0	0.0	10.5	34.1	0.0	9.6	40.1	0.0	10.0	*
27	W610S X LH287	44.7	0.0	9.1	36.1	0.0	8.9	40.4	0.0	9.0	*
28	W609S X LH244	49.6	0.0	9.2	38.1	0.0	9.1	43.9	0.0	9.2	*
29	34A20	47.8	0.0	10.1	39.0	0.0	9.4	43.4	0.0	9.8	*
30	F2F633	41.8	0.0	8.0	29.9	0.0	6.5	35.9	0.0	7.3	*
31	N48V8	46.3	0.0	9.5	36.1	0.0	10.0	41.2	0.0	9.7	*
32	36H56	44.9	0.0	8.6	36.6	0.0	9.2	40.7	0.0	8.9	*
	Mean	48.2	0.0	8.8	37.1	0.0	8.4	42.6	0.0	8.6	
	CV (%)	4.9	.	9.5	5.8	.	14.8	5.3	.	12.3	
	LSD (0.05)	3.8	.	1.4	4.3	.	2.5	2.6	.	1.2	
	Mean of all GEM50390 testcrosses	49.0	0.0	8.6	37.6	.	8.2	43.3	0.0	8.4	
	Mean of experimental entries for quality evaluation	48.5	0.0	9.1	37.8	0.0	8.9	43.1	0.0	9.0	
	Mean of checks (w/o F2633)	45.6	0.0	9.0	36.4	0.0	9.6	41.0	0.0	9.3	
	Entries marked with "*" will be analyzed for nutritional quality										

Reference:

USDA - United States Department of Agriculture. National Agricultural Statistics Service. 2011.
Crop Production 2010 Summary.
(http://usda.mannlib.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2011_new_format.pdf)