

Registration of Nine High-Yielding Tropical by Temperate Maize Germplasm Lines Adapted for the Southern USA

Nine maize (*Zea mays* L.) germplasm lines have been developed by the USDA GEM (Germplasm Enhancement of Maize) project (Reg no. GP-501-509, PI 639497-639505, see Table 1). The GEM project is a cooperative research effort to facilitate the introduction of exotic maize germplasm into U.S. breeding programs. It involves most U.S. maize breeding companies and many public cooperators (Pollak, 2003; Pollak and Salhuana, 2001; Goodman, 1999; Goodman and Carson, 2000; Goodman et al., 2000). Replicated breeding trials coordinated by North Carolina State University as part of the GEM project, and conducted by several public and private GEM cooperators, have identified nine superior F₂S₂ germplasm lines (S₂ lines derived from an F₂ population) containing 50% tropical germplasm by pedigree. When topcrossed to sister-line crosses or foundation-seed inbreds, these germplasm lines have yielded well in North Carolina and other southern corn growing regions of the USA in comparison to commercial check hybrids (i.e., their yields were either significantly higher or not statistically significantly different from the yields of the commercial check hybrids). They also performed at least as well as commercial check hybrids by several other criteria enumerated below. Table 1 shows the GEM names designated for these sources alongside their previous identifiers.

The source of the tropical germplasm involved in these nine novel germplasm lines is the Brazilian population PE1 (also known as BR51403). PE1 is a composite of varieties from the state of Pernambuco, Brazil. The U.S. parent of the germplasm was a privately owned inbred line of the nonstiff stalk heterotic group. These germplasm lines were developed by selfing and selecting within variable F₃s from crosses between the tropical-source (i.e., different individuals from the PE1 population) and the U.S. inbred, in North Carolina under standard nursery conditions. F₂ seed were bulked and used for a second selfing/selection season in Homestead, FL. Nine hundred ninety F₃ progenies, each derived from the self of a different F₂ plant, were tested for per-se yield in unreplicated yield trials at the Sandhills Research Station in North Carolina in 1996. The top 10% were selected for further selfing and topcrossing in a winter nursery at Homestead, FL. All procedures were performed using ear-to-row methods (i.e., each row was planted with seeds from a single ear), except that F₂ seeds planted at

Homestead were bulked by pedigree (i.e., all the F₂ seed from each tropical source × U.S. inbred were bulked). Germplasm lines were visually selected on the basis of resistance to lodging, early flowering, synchrony of silk and pollen production, and reduced plant and ear height.

Topcross seed for initial yield trials were produced using the sister line cross FR992 × FR1064 (provided by Illinois Foundation Seeds) as tester. These seed were used for yield trials in 15 test locations from Delaware to Georgia and as far west as Missouri over 2 yr (1997 and 1998). These states were Delaware (1 location), Georgia (3 locations), Kentucky (2 locations), Maryland (1 location), Missouri (2 locations), North Carolina (4 locations), Tennessee (1 location), Texas (1 location). The released germplasm lines were among the top performers in these tests. The seed moisture of the sources being registered was not significantly higher or was lower than the commercial hybrid check means in all cases and lodging was acceptable as well. These data are detailed in Table 1. Additional yield experiments were conducted with GEMS-0042, GEMS-0033, and GEMS-0037, top crossed to the stiff-stalk testers LH200 and LH244 and tested at several locations throughout the southern Corn Belt in 2001 and 2002. In these experiments the germplasm lines produced superior yields to elite hybrid checks, yielding between 9500 and 9800 kg ha⁻¹ compared with a hybrid check mean of 9390 kg ha⁻¹ (The checks in this case were Dekalb brand 687; Pioneer brands 30F33, 32K61, and 3165; NC320 × T7; LH132 × LH51 and LH200 × LH262).

In yield trials conducted in the mid-western Corn Belt (Iowa, Missouri, and Illinois) using LH200 and LH198 as testers, the yields of all of these germplasm lines were inferior to the hybrid check means. GEMS-0035 (8786 kg ha⁻¹), GEMS-0039 (8704 kg ha⁻¹), and GEMS-0042 (8604 kg ha⁻¹) yielded best in top crosses with LH200, compared to the hybrid check mean of 9765 kg ha⁻¹. (The checks in this case were Pioneer brands 31G98, 34B23, 33P66; LH198 × LH185 and LH200 × LH262). GEMS-0039 (9527 kg ha⁻¹), GEMS-0036 (8817 kg ha⁻¹) and GEMS-0037 (8786 kg ha⁻¹) yielded best in top crosses with LH198, compared with a hybrid check mean of 9602 kg ha⁻¹. (The checks in this case were Pioneer brands 31G98, 34B23, 33P66; LH198 × LH185 and LH200 × LH262).

These materials have a range of kernel colors; Orange and yellow (GEMS-0040), orange (GEMS-0037), yellow and yellow cap (GEMS-0036 and GEMS-0042), yellow cap (GEMS-0035) and yellow (all others). A range of kernel textures are

Table 1. The GEM ID numbers and PI numbers of the nine germplasm lines registered with their pedigrees.

PI number	GEM number	Pedigree	Yield†	Moisture†	Erect plants†
			kg ha ⁻¹	g kg ⁻¹	%
639497	GEMS-0033	PE001n16F2S2-44	8970	194	91
639498	GEMS-0035	PE001n16F2S2-172	8847	183	91
639499	GEMS-0036	PE001n16F2S2-176	8216	187	96
639500	GEMS-0037	PE001n16F2S2-181	8437	193	95
639501	GEMS-0039	PE001n16F2S2-239	8214	190	98
639502	GEMS-0040	PE001n16F2S2-431	8195	194	95
639503	GEMS-0041	PE001n16F2S2-521	8221	186	93
639504	GEMS-0042	PE001n16F2S2-705	8484	190	95
639505	GEMS-0043	PE001n16F2S2-857	8668	183	95
		Check Mean‡	8,198	192	93
		DK689	8,358	194	92
		DK714	8,673	187	92
		LH132 × LH51	8,120	182	97
		P3165	8,308	218	90
		P3245	7,498	173	96
		P3394	7,825	160	97

† Yield (kg ha⁻¹), moisture (g kg⁻¹), and erect plant (%) data are shown from yield trials conducted in 1997 and 1998 with topcross seed produced using FR992 × FR1064 as the tester.

‡ GEM's protocol is to compare performance relative to the means of widely used commercial checks. The individual checks are shown in italics below the check mean (Dekalb brands 689 and 714, LH132 × LH51 and Pioneer brands 3165, 3245, and 3394).

also found; semiflint to semident (GEMS-0036, GEMS-0040, and GEMS-0042), semiflint (GEMS-0035) and semident (all others). These data can be found by querying the database found on the GRIN website (http://www.ars-grin.gov/npgs/acc/acc_queries.html; verified 24 April 2006).

At Clayton, NC, in 1999, flowering times for the GEM germplasms were 0 to 10 d later than B73 with GEMS-0036, -0039 and -0041 all flowering within one or 2 d of B73. Flowering of germplasm sources per se occurred between 8 and 19 d later than B73 at Ames, IA, in 2002. The earliest germplasm was GEMS-0039 (8 d later than B73) and the latest was GEMS-0037 (19 d later than B73). In 2003 at Ames, flowering occurred between 11 and 18d later than B73. The earliest flowering germplasm was again GEMS-0039 (11 d later than B73) and GEMS-0044 was the latest (18 d later than B73).

On the basis of 2 yr of data on resistance to gray leaf spot (caused by *Cercospora zae-maydis* Tehon & E.Y. Daniels) from Salisbury, NC, the per se germplasm sources GEMS-0033 (mean rating of 7.5 on a 1–9 scale with 1 being completely susceptible and 9 being completely resistant), GEMS-0035 (mean rating 7.25), and GEMS-0037 (mean rating 7.4) were about as resistant to gray leaf spot as the resistant checks DK683 (mean rating 7.25) and NC258 (mean rating 7.25); the remainder of the lines were intermediate in resistance, with GEMS-0039 (mean rating 6.4), GEMS-0043 (mean rating 5.9), and GEMS-0040 (mean rating 5.8) being more resistant than GEMS-0036 (mean rating 4.9), GEMS-0041 (mean rating 4.9), and GEMS-0042 (mean rating 5.0). GEMS-0033, -0037, -0039, and -0042 were also tested per se for gray leaf spot resistance at Andrews, NC, in 2001 (mean ratings 5.7, 6.3, 5.3, and 4.7, respectively). All these germplasms could be considered resistant though only GEMS-0037 was as resistant as the resistant check lines NC250 and NC258 (mean rating for both 6.3). All the per se germplasm sources registered here were more susceptible to southern leaf blight [caused by *Cochliobolus heterostrophus* (Drechs.) Drechs., mean ratings between 5 and 7) than the resistant check NC258 (mean rating 8) on the basis of data from 1 yr from Clayton, NC. All are considered to have intermediate resistance, with the exception of GEMS-0041, which is susceptible.

These germplasm lines provide a unique source of tropical maize germplasm for the development of lines with improved

yield and disease resistance. They have particular utility for developing lines adapted to conditions in the southern USA. Bulk $F_2S_{2:3}$ or $F_2S_{2:4}$ seed is available from the North Central Plant Introduction Station, USDA-ARS, Iowa State University, Ames, IA 50011. These materials are released without restrictions of any kind.

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doi:10.2135/cropsci2005.08-0283

Published in Crop Sci. 46:1825–1826 (2006).