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Registration of Nineteen Waxy Spring Wheats

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Nineteen spring waxy (amylose-free) wheat (*Triticum aestivum* L.) germplasm lines (Reg. no. GP-748 to GP-766, PI 619354–619357, 619359–619363, 619365–619369, 619371–619375) were developed and released by the ARS, USDA, and the Nebraska Agricultural Experiment Station in cooperation with the Agricultural Experiment Stations of North Dakota and Idaho in September 2002. Waxy wheats carry three nonfunctional (null) alleles (*Wx-A1b*, *Wx-B1b*, and *Wx-D1b*) at the genetic loci encoding the enzyme granule-bound starch synthase (GBSS, EC 2.4.1.21) (Nakamura et al., 1995). GBSS also is known as the "waxy" protein. Waxy wheats produce endosperm starch that is nearly devoid of amylose. Such starch confers unique functional properties to derived wheat flour. Suggested uses for waxy wheats include the production of modified food starches, a blending agent to create flours with optimal amylose concentration for the production of a variety of sheeted and baked food products, and as an animal feed (reviewed by Graybosch, 1998). Waxy wheats also are useful as donors of the *Wx* null alleles, which may be used to develop partial waxy or reduced-amylose wheats. The presence of one or two such alleles can result in wheat flours with superior performance in certain food applications including white salted noodles (Epstein et al., 2002). Few waxy wheats have been publicly available to date, and those released (Morris and Konzak, 2001) are ill-adapted to North American spring wheat production zones. The release of this set of 19 waxy lines greatly expands the number of available genetic backgrounds carrying the waxy trait in wheat. Pedigrees and Plant Introduction (PI) numbers of the lines are listed in Table 1.

Lines were developed from matings between Asian and North American sources of the *Wx* null alleles. After the last cross in each pedigree, the brush end of F_2 plants was stained with a dilute solution of I_2KI and the germ end was saved for planting. Under these staining conditions, waxy seed were identified by their red-brown color, as opposed to the dark purple-black color typical of wild-type or partial waxy lines (Nakamura et al., 1995). F_2 plants were grown, without vernalization, in greenhouses in the fall of 1998, and maintained and harvested individually. Only true spring growth habit types (e.g., those that flowered and set seed under nonvernalizing conditions) were harvested. F_2–derived F_3 single-plant progeny rows were grown at Aberdeen, ID, USA in the spring of 1999. At harvest the 19 $F_{2:4}$ waxy lines were selected from these progeny rows, on the basis of uniformity of phenotype under field conditions and uniformity of the waxy trait.

Grain yields of the 19 waxy lines, based on replicated tests in three locations (Fargo, ND and Aberdeen, ID, 2000; Mead, NE, 2001), are given in Table 2. Grain yields ranged from a high of 3606 kg/ha in PI 619362 to a low of 2076 kg/ha in PI 619360. In the same testing environments, the spring wheat cultivars 'Express' (PI 573003), 'Westbred 926' and 'Klasic' (PI 486139) averaged 3441, 3703, and 2799 kg/ha, respectively. On the basis of assessment by a Perten Single Kernel Hardness Characterization System, mean hardness scores (Table 2) identified three soft endosperm textured wheats, while the remaining 16 waxy wheats were classified as hard wheats. Fifteen of the lines breed true for red grain color, while four are heterogeneous for red and white grain (Table 2).

Table 2 also lists postulated resistance genes to foliar diseases. On the basis of reactions to current races of leaf rust

Table 1. Plant Introduction (PI) numbers, experimental line designations, and pedigrees of 19 spring waxy wheats.

PI no.	Experimental line designation	Pedigree
619354	99ID388	Kanto107/MN2540/3/BaiHuo5/K94H115//IDO469
619355	99ID389	Kanto107/MN2540/3/BaiHuo5/K94H115//IDO469
619356	99ID435	BaiHuo/L910097//Kanto107/3/Kanto107/Yanshi9
619357	99ID450	BaiHuo3/Cimarron//MN91227/3/Kanto107
619359	99ID477	BaiHuo/Chris//Kanto107
619360	99ID484	BaiHuo/L910097//Kanto107/3/BaiHuo3/Cimarron//MN91227
619361	99ID490	BaiHuo/Kanto107//Express
619362	99ID496	BaiHuo/Kanto107//Express
619363	99ID498	BaiHuo/Kanto107//Express
619365	99ID516	KY87C-42-8-5/Collin//ACMajestic/3/Kanto107/BaiHuo
619366	99ID520	KY87C-42-8-5/Collin//ACMajestic/3/Kanto107/BaiHuo
619367	99ID524	KY87C-42-8-5/Collin//ACMajestic/3/Kanto107/BaiHuo
619368	99ID529	KY87C-42-8-5/Collin//ACMajestic/3/Kanto107/BaiHuo
619369	99ID536	KY87C-42-8-5/Collin//ACMajestic/3/Kanto107/BaiHuo
619371	99ID548	Penawawa/NE92608//BaiHuo/3/BaiHuo4/Kanto107/A92-3327/Kanto107
619372	99ID554	Kanto107/BaiHuo//BaiHuo/Russ
619373	99ID569	BaiHuo/Kanto107//ACMajestic
619374	99ID590	BaiHuo/ACMajestic//Kanto107/MN2540
619375	99ID594	BaiHuo/Gunnar//Kanto107/Penawawa

Table 2. Mean grain yield, grain hardness class, and grain color characteristics of 19 waxy spring wheats.

				Postulated resistance genes†	
Line	Grain yield	Grain hardness class	Grain color	leaf rust	stem rust
	kg/ha				
619354	2257	hard	red	+	none
619355	2984	hard	red	none	none
619356	2660	hard	red	14a, +	10 or 17
619357	2352	soft	red	+	none
619359	2611	hard	red	16, +	none
619360	2076	hard	red	none	none
619361	3228	soft	red/white	1, +	none
619362	3606	hard	red	+	none
619363	2828	hard	red	none	none
619365	2829	hard	red	9, +	10 or 17
619366	3104	hard	red/white	+	36
619367	2633	hard	red/white	+	10 or 17
619368	3443	hard	red/white	9, +	10 or 17
619369	2955	hard	red	+	none
619371	2960	hard	red	none	none
619372	2588	hard	red	16, +	none
619373	2682	hard	red	+	none
619374	2897	hard	red	+	10 or 17
619375	3299	soft	red	+	none

† + designates presence of unknown gene postulated.

(caused by *Puccinia recondita* Roberge ex Desmaz.), the following resistance genes are postulated as being present in the respective waxy lines: *Lr1*, PI 619361; *Lr16*, PI 619372, PI 619359; *Lr14a*, PI 619356; *Lr9*. PI 619368, PI 619365. Unidentified additional leaf rust resistance genes are speculated to occur in all lines with the exception of PI 619363, PI 619360, PI 619371, and PI 619355. These last four lines are susceptible to current leaf rust races. Resistance genes to current races of stem rust (caused by *Puccinia graminis* Pers.: Pers.) occur in PI 619356, PI 619367, PI 619388, PI 619374, and PI 619365 (*SR10* or *Sr17*). Resistance gene *Sr36* was found in PI 619366. The remaining lines are susceptible to current races of stem rust.

Seed of all lines has been deposited in the USDA National Small Grains Collection, Aberdeen, ID. Small quantities of seed may be obtained from R. Graybosch, USDA-ARS, University of Nebraska, Lincoln, NE 68583. It is requested that the source of this material be acknowledged in future usage by wheat breeding and genetics programs.

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