AS12 Leaf-rust-resistant Sweet Corn (*Zea mays* L.) Population

D.W. Davis¹, J.V. Groth², G.R. Ginger³, W.M. Randle⁴, and C.A. Engelkes⁵

University of Minnesota, St. Paul, MN 55108

Additional index words. maize, vegetable breeding, sustainable agriculture, biocontrol, *Puccinia sorghi*

Common corn leaf rust, caused by *Puccinia sorghi* Schw., is a serious disease of sweet corn in many areas of the United States and frequently requires chemical control. Commercial hybrids carrying single-gene, hypersensitive resistance are available but may be vulnerable to an increase in virulent pathogen genotypes. AS12 (PI 578125/NSSL 289952.01) is a *sugary-1* population of sweet corn having a high degree of partial resistance to *P. sorghi*, and thus is being released as improved germplasm.

Origin

AS12 is a derivative of a sweet corn (*sugary-1*) × tropical maize composite (1B/1R) initiated in 1968 by D.W.D. by hybridizing 17 cultigens from Peru, Mexico, and Cuba (Rubino and Davis, 1990, 1991) with each of nine U.S. state agricultural experiment station *sugary-1* inbreds and two proprietary *sugary-1* inbreds adapted to the Midwest (Fig. 1, Table 1). These 11 U.S. inbreds were generally recognized for excellence in combining ability for yield, but varied widely in earliness, quality, and type, and were highly susceptible to leaf rust. Following self-pollination of the 187 F₁s and the bulking of equal amounts of F₂ seed from each cross, four generations of random mating were conducted, beginning in 1970 (Fig. 1). Each year two fields were planted, one in isolation for open-pollination and the other for controlled crosses. Each field contained ≈7000 plants/year. Based on knowl-

edge of variation in earliness, planting times within each field were staggered through the spring to reduce assortative mating for earliness. All the plants that set seed in the isolation field were harvested, and an equal amount of seed for the next generation was saved from each and bulked. In the crossing field, 400 to 500 crosses emphasizing early by late combinations were handmade across the staggered planting dates to maintain variability, with all females contributing an equal amount of seed to the next generation. Equal amounts of seed from the two fields were bulked at harvest.

This program was continued annually through 1973.

After the 1973 harvest, the composite seed was divided into two subcomposites, 1B and 1R (Fig. 1). From 1974 through 1978, 1R was cycled as a “low stress composite” on a silty clay loam soil (mixed, mesic Typic Hapludoll) at Rosemount, Minn. (Location 1). Composite 1B was cycled as a “high stress composite” on a droughty loamy sand soil (sandy, mixed Udorthentic Haploborolls) at Becker, Minn. (Location 2). Neither site was irrigated. Recurrent stratified grid mass selection for phenotype was performed each year on ≈14,000 open-pollinated plants in an isolation field at each location, with one in 10 plants selected for earliness, vigor, freedom from diseases and pests, and for plant, ear, and kernel type. An equal amount of seed from each of these selected plants was bulked to provide seed for the next year.

In 1979, 400 to 500 plants each of 1B and 1R were grown at St. Paul, Minn., in a leaf rust nursery. Selfing and sibbing of relatively resistant plants was practiced (Fig. 1). Ear-to-row nonreplicated progeny testing plus additional selfing and sibbing were practiced in

*Population Reconstituted each year by bulking equal amounts of seed from the two locations.

**Stratified Grid Selection in high stress and low stress environments each year.

***Self or Sib single plant rust resistant selections.

Fig. 1. Pedigree of AS12 leaf-rust-resistant sweet corn population (Location 1 = Rosemount, Minn., and Location 2 = Becker, Minn.). No plants were grown from 1982 to 1986.

Received for publication 28 Mar. 1994. Accepted for publication 13 Jan. 1995. Minnesota Agricultural Experiment Station Journal series no. 21,084. We acknowledge with thanks the financial support of the Midwest Food Processors Association in this research. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

¹Professor, Dept. of Horticultural Science.

²Professor, Dept. of Plant Pathology.

³Graduate Research Assistant, Dept. of Horticultural Science.

⁴Formerly, Graduate Research Assistant, Dept. of Horticultural Science; currently, Associate Professor, Dept. of Horticulture, Univ. of Georgia, Athens.

⁵Formerly, Graduate Research Assistant, Dept. of Horticultural Science; currently, Research Associate, Univ. of Minnesota Northwest Experiment Station, Crookston.

Table 1. Parents of sweet corn composites 1B and 1R used in the development of AS12 leaf-rust-resistant population.

Tropical parents and sources ^a		U.S. inbred
Peru	Mexico ^b	<i>sugary-1</i> parents
Paro	Elotes Conicos (Compuesto Guanajuato Grupo 13)	I453
Chullpi	Elotes Conicos (Compuesto Guanajuato Grupo 14)	I5125
Huayleno	Ancho (Compuesto Guanajuato Grupo 15)	P39
Piscorunto	Conico/Celaya (Compuesto Puebla Grupo 12)	P51
Compuesto Dulce	Tabloncillo (Michoacan 4)	GG22
Chapareno	Maiz Dulce (Michoacan 15)	GG62
	Maiz Dulce (Guanajuato 93A)	C6
	Dulcillo Del Noroeste (Sonora 57)	C13
	Maiz Dulce (Jalisco 188)	III 18b
	Elotes Conicos (Guanajuato 98)	III 27a
	P.M.S. 265 (Station Rone V 67) ^c	III 101t

^aTropical cultigens are considered exotic with regard to adaptation and to U.S. domestic industry and consumer specifications, but most were acceptable for culinary uses in their region of origin. 'Chullpi' and the four 'Dulce' entries possess *sugary-1* endosperm.

^bFrom Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT).

^cContains Cuban germplasm.

Fig. 2. Progression of the severity of common leaf rust on the 0 to 9 scale in 1993 at the Univ. of Minnesota for sweet corn population AS12 and several commercial hybrids. Vertical bars represent the LSD ($P \leq 0.05$) among genotypes at each of several growth stages according to Ritchie and Hanway (1982). The V5 and V7 categories represent the fifth- and seventh-leaf vegetative stages, respectively; R1 is the silking stage; and R1 + 7 and R1 - 7 designates R1 plus and minus 7 days, respectively.

1980 and 1981. Population 29 was developed by pedigree selection following hybridization in 1987 of 80MF 1B-5, an S_1 selection derived in 1980 from subcomposite 1B, and 81MF 1301BS, a sib selection derived in 1981 from subcomposite 1R (Randle et al., 1984). Leaf rust resistance was further improved by recurrent pedigree selection beginning with the selfing of an F_2 plant (2852-9) in 1988. Six of the most resistant plants were selfed from the F_3 family 89MF 3103 in 1989 and were recombined via open pollination in isolation in 1990 as Population 29. AS12 resulted from open pollination of Population 29 in isolation in 1991 and 1992 with selection for plant uniformity, improved tassel structure, earliness, and improved ear conformation, and for resistance to rust and to common smut (*Ustilago maydis* (DC) Cda.

Description and performance

AS12 possesses a high degree of uniformity for plant and ear traits. Plants are narrow-leaved, generally have one to two full-size tillers, and are 1.8 to 2.0 m tall under Minnesota conditions. Ears have dark silk and 14 to 16 rows of kernels. Kernels are small and medium yellow in color. AS12 is medium in maturity, flowering at 1200 heat units.

AS12 typically scores from 1 to 2 on the 0 to 9 leaf rust reaction scale (Davis et al., 1988) under epidemic conditions, where 0 = absence of disease symptoms and 1 to 9 represent 0.68%, 2.1%, 5.7%, 11.5%, 20%, 36%, 55%, 80%, and 96% diseased leaf area, respectively (Randle et al., 1984). Commercial hybrids, such as 'Miracle' and 'More', which have a quantifiable degree of partial resistance, typi-

cally have much more leaf rust than AS12 during leaf rust epidemics across a range of plant growth stages (Ritchie and Hanway, 1982) (Fig. 2). The partial resistance of AS12 is similar (unpublished data) to that documented earlier for the upper 3% of S_1 s derived from composite 1B/1R (Davis et al., 1990). Our interpretation has been that the high degree of resistance in AS12 is not of the single-gene, hypersensitive form typical of the *Rp* series (Groth et al., 1992).

Uses

AS12 has potential as a germplasm source for partial resistance to common leaf rust. Backcrossing or recurrent selection with recombination could be used to transfer the resistance to the parental inbreds of commercial hybrids.

Realized heritabilities in the 1B and 1R subcomposite material have ranged from 3% to 45%, and gain from selection has ranged from 11% to 28% per generation (Randle et al., 1984). Gingera et al. (1994) found a similar gain from selection following outcrossing of 1B/1R germplasm to commercial sweet corn. Thus, the resistance found in AS12 could be used for hybrid improvement.

Availability

Breeder seed is maintained and distributed in 500-kernel lots by the Minnesota Crop Improvement Association, 1920 Hendon Avenue, St. Paul, MN 55108.

Literature Cited

- Davis, D.W., C.A. Engelkes, and J.V. Groth. 1990. Erosion of resistance to common leaf rust in exotic-derived maize during selection of other traits. *Phytopathology* 80:339-342.
- Davis, D.W., W.M. Randle, and J.V. Groth. 1988. Some sources of partial resistance to common leaf rust (*Puccinia sorghi*) in maize and strategy for screening. *Maydica* 33:1-13.
- Gingera, G.R., D.W. Davis, and J.V. Groth. 1994. Pedigree selection for improved partial resistance to common leaf rust in sweet corn. *Crop Sci.* 34:615-620.
- Groth, J.V., J.K. Pataky, and G.R. Gingera. 1992. Virulence in eastern North America populations of *Puccinia sorghi* to *Rp* resistance genes in corn. *Plant Dis.* 76:1140-1144.
- Randle, W.M., D.W. Davis, and J.V. Groth. 1984. Improvement and genetic control of partial resistance in sweet corn to corn leaf rust. *J. Amer. Soc. Hort. Sci.* 109:777-781.
- Ritchie, S.W. and J.J. Hanway. 1982. How a corn plant develops. Iowa State Univ. Coop. Ext. Serv. Spec. Rpt. 48, Ames.
- Rubino, D.B. and D.W. Davis. 1990. Response of a sweet corn x tropical maize composite to mass selection for temperate-zone adaptation. *J. Amer. Soc. Hort. Sci.* 115:848-853.
- Rubino, D.B. and D.W. Davis. 1991. Maintenance of tropical isozyme alleles during random mating in a semiexotic maize composite. *J. Hered.* 82:423-425.