‘Hawaiian Supersweet Silver’

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Tropical sweet corn production has developed largely from open-pedigree populations with a broad genetic base in tropical and temperate food corn varieties. Integral to this development have been the open-pollinated varieties ‘Hawaiian Sugar’ (Brewbaker, 1968), bred by A.J. Mangelsdorf in Hawaii, and ‘Hawaiian Supersweet #9’ (Brewbaker, 1977). These populations were based respectively on genes *sugary1* and *brittle1*, and both were yellow endosperm. During the past two decades, the high-sucrose gene *brittle1* has come to dominate sweet corn production in the tropics, the largest share of which is in Thailand (70,000 ha in 2005). Processed corn is predominantly yellow in endosperm, but many people throughout the tropics prefer to eat corn that has pearly white endosperm, mimicking rice. We have previously released 20 tropical sweet corn populations (Brewbaker, 1998; Brewbaker and Scully, 2002; Scully et al., 2001) with high tolerance to many diseases common in the tropics. White and pale-yellow endosperm genes segregate in some of these populations, but none have been pure white. It is evident that all-white endosperm corn must carry the gene *y1*, which appears to be rate limiting in carotenoid accumulation via phytoene synthase pathways. However, it is greatly oversimplified to assume that yellow corn can be converted to white by inserting this single gene, because there are many types of pale yellows among tropical maize races. Eliminating these pales was one of the challenges in breeding the *brittle1* high-sucrose variety, ‘Hawaiian Supersweet Silver’, as evident in the 16-year, 24-generation breeding program that precedes this release.

Origin and Breeding

‘Hawaiian Supersweet Silver’ is known technically as Hi bt COMP 9x, representing the ninth in a family of genetically broad-based supersweet populations bred in Hawaii, and the 24th cycle (x) of selection.

These *bt1* composites are based largely on open-pollinated parental populations or hybrids, and five have been released previously (Brewbaker, 1998). COMP 9 is primarily a conversion of Hi bt COMP 3, released commercially as ‘Hawaiian Supersweet #9’. The full breeding pedigree is as follows:

(Hi bt COMP 3 × NE-IR)

S₁ BC₅ S₂ BC # BC #₃ C S C₂ #₃ C #₂

where S = self, BC = backcross to COMP 3, # = sib, and C = chain-sib. The 24 cycles of breeding began with the cross of COMP 3 to population NE-IR, an insect-resistant population developed by D. Davis (Univ. Minn.). NE-IR is one of the intercollegiate varieties developed under project NE-124, which also includes the NE-EDR released in Hawaii and Florida (Brewbaker and Scully, 2002; Scully et al., 2001). NE-IR was *sugary1* and had white sweet corn hybrids in its parentage. From two selfing generations of the original cross of COMP 3 × NE-IR, white kernels were selected for the first backcross. Pale-yellow segregants were selected from successive backcrosses and assumed to represent the heterozygous *Y/Yy* endosperms. The five backcrosses were followed by two self generations and two more backcrosses and sibs. Subsequent cycles of breeding and recurrent selection often occurred under managed epiphytotic and involved four chain-sib populations from which only the pearly white ears at both sweet corn stage and maturity were saved. It was evident that pale-yellow endosperm was often the result of other loci rather than that of heterozygosity at locus *y1*, as discussed later.

Recurrent selection in Hi bt COMP 9x involved many agronomic and tolerance traits. Breeding nurseries were grown every month of the year (we grew 240 nurseries throughout the 15 years of breeding COMP 9). No seed treatments were applied, nor was there any application of pesticides. Under these conditions, very few temperate sweet corns could be harvested commercially. Common diseases and stresses included maize mosaic virus, common rust (*Puccinia sorghi* Schw.), southern rust (*Puccinia polysora* Underw.), *Fusarium* rots [(*Fusarium verticillioides* (syn. *F. moniliforme* Scheld.)], northern leaf blight [*Exserohilum turcicum* (Pass.) Leonard & Suggs], brown spot (*Phyoderma maydis* Miyabe), bacterial leaf blight (*Acidovorax avenae*), earworms [*Helicover-*

pa zea (Boddie)], high temperatures, and low light. None of the control temperate hybrids survived the *Fusarium* seedling rot, the virus, or the southern rust. A detailed description of selection procedures for most of these problems is given by Brewbaker (1998). Recurrent mass or full-sib selection for Hi bt COMP 9 involved overplanted breeding nurseries thinned to a stand density of 50,000 ha⁻¹ before pollination. At least 100 ears were selected among ≈1000 plants for genetic advance. Most cycles of breeding were paired with yield trials in which the Hi bt COMP 3 was grown as a control.

Description

Kernel color

Hi bt COMP 9 is known to be homozygous for white endosperm *y1*. Pale-yellow kernels at sweet corn stage segregated continually during breeding, but are believed to be completely absent in cycle x. At least one of these pale-yellow mutants was white at sweet corn stage but pale yellow when mature—an apparently delayed carotenoid synthesis. One common pale yellow at sweet corn stage that segregated monogenically was shown to be *y8* through test crosses with our near-isogenic lines (NILs) of inbred Hi27. These NILs (Brewbaker, 1995) include five different off whites or pale yellows, of which two proved to be *y8* and *y11*. The *y8* locus occurs in some of the hybrids marketed by Hawaii Foundation Seeds, and creates an attractive bicolor segregation in *Y/Y* background or tricolor segregation in *Y/y* background. The *y8* gene was also common (35% phenotypic frequency) in our composite: NE-EDR *bt1* (Brewbaker and Scully, 2002). The gene *y1* is said also to be pale yellow in some backgrounds, and four other reported pales may be allelic to the *y1*, *y8*, and *y11* loci (Neuffer et al., 1997). Concurrent conversions to *y1* were made using two flint inbreds (Hi27, Hi34) and three supersweet inbreds (Hi36, Hi37, Hi38). The allele *y8* was encountered among these as well, and was retained as sublines in Hi27 and Hi36. The inbred conversions were comparatively simple, because only a single plant needed to be retained per cycle of backcrossing or selfing.

Horticultural traits

Hi bt COMP 9 resembles tropical field corns horticulturally, and thus is quite distinct from temperate sweet corns. It does not tiller and only rarely shows flag leaves (<2% of plants). It is tall (2.5 m) with ears at 75 cm (<10% above 1 m). Brace roots are ubiquitous and very strong in COMP 9, and lodging is rare—a major improvement over Hi bt COMP 3. In many other respects, COMP 9 resembles COMP 3 (Brewbaker, 1998). For example, maturity averages 70 d to sweet corn harvest in Hawaii (at an average temperature of 25 °C), about 1 week later than common commercial U.S. hybrids. COMP 3 was delayed about 10 d to flowering by temperate long days, and COMP 9 is assumed to be similarly day length responsive. Husk

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numbers range from 11 to 14, well in excess of temperate hybrids. Ears are somewhat tapered and earworm damage is minimal even under the severe epibiotics of Hawaii. Ears average 16 cm in length with 12 to 14 rows, and kernels average 9.5 mm in depth. At least four yield trials annually have included the evolving COMP 9, always in absence of fungicide or insecticide treatment. It has always been among the top 20% in yield and taste quality of entries tested in trials that include several single-cross and three-way hybrids. Temperate growers will not relate to yields in Hawaii that vary at least 100% during the year as a result of light variations (Brewbaker, 2003). However, yields of marketable ears per acre for COMP 9 average ~50,000 ha⁻¹, and filled ear lengths range from 15 cm in winter to 20 cm in summer. Sweetness and tenderness are high and comparable with commercial *bt1* and *sh2* hybrids.

Disease Resistance

Hi bt COMP 9 was bred under conditions similar to NE-EDR populations (Brewbaker and Scully, 2002), but with a higher proportion of tropical heritage. COMP 9 exceeds NE-EDR in tolerance of southern rust and *Fusarium* kernel and seedling rot, but is similar in tolerance of viruses, bacteria, and

other diseases. No single genes for race-specific resistance are present (e.g., *Rp1-d*, *Rpp9*, *Ht1*, or *Ht2*). COMP 9 is impressive in the rarity of damage by thrips (*Frankliniella* sp.). Thrip damage is severe for seedsmen in Hawaii, and encourages multiple applications of pesticide. The tolerance of thrips may be related to COMP 9's high tolerance to *Fusarium* rots of kernel and seedling, which appear to be exacerbated by thrip damage. Dry seeds of COMP 9 are normally harvested after plant senescence (about 100 d from planting), and only rarely show kernel damage or reduced germination from *Fusarium* sp. or *Aspergillus* sp. Earworm injury is minimized as a result of high husk number and tip cover beyond the cob.

Availability

All seeds are open pedigree and available at cost from Hawaii Foundation Seeds, Department of Tropical Plant and Soil Science, College of Tropical Agriculture and Human Resources, Univ. of Hawaii, 3190 Maile Way, Honolulu, HI 96822. Hi bt COMP 9x represents major genetic improvement (agronomy, disease tolerance) of the population tested by growers earlier as '9 Silver' (cycle n of selection). The composite has been provided to the U.S. National Germ-

plasm Resources Laboratory, Fort Collins, Colo. Recipients are requested to acknowledge the use of this population in research, patenting, or germplasm development.

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