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Dictionary of Traits for Fresh Market Sweet Corn Production in Florida

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ABSTRACT

Unlike other corn (*Zea mays* L.) production regions in the U.S., the Florida corn industry is dominated by sweet corn cultivars grown for the winter vegetable market. Florida further specializes in fresh market cultivars that are almost exclusively based on the *Shrunken 2 (sh2)* endosperm. In much of south Florida this crop is hand harvested, while machine harvest methods are more common in north and central areas of the state. These unique aspects of the sweet corn industry require the use of specific cultivars, and the management decisions concerning the choice of cultivars for production differ from processed sweet corn and field corn. We propose a dictionary of primary traits that influence the selection of cultivars for production and that are economically important to the Florida sweet corn industry. An additional set of secondary traits are incorporated into the dictionary to augment the descriptive process, but most of these are not economically important. Both primary and secondary traits are grouped on the basis of morphology, physiology and response to biotic stress. For logistic purposes these primary traits were assigned to subsets of four to ten traits that are measured during the various stages of crop development. These include the seedling, tassel, pre-harvest, field harvest, pre-husk, ear evaluation, and the disease/pest evaluation phase. The biology of diseases and insect pests vary in severity and distribution depending on the site, season of production, regional cropping patterns and current management practices. Resistance traits that are of primary importance in one circumstance may be only of secondary importance in another. None of the secondary traits were assigned for measurement in these subsets, but could be included wherever needed.

RESUMEN

A diferencia de otras áreas productoras de maiz en los Estados Unidos, la industria del maiz en Florida es dominada por los cultivares de maiz dulce sembrados para el mercado de vegetales de invierno. El estado de Florida se especializa además en cultivares para mercado en fresco que están basados casi exclusivamente en el endospermo *Shrunken 2 (sh2).* En gran parte del sur de Florida este cultivo se cosecha manualmente, mientras que los métodos de cosecha por máquina son más comunes en las áreas central y norte del estado. Estos aspectos únicos de la industria del maiz dulce obligan al uso de fenotipos de cultivares especificos. Las decisiones de manejo concernientes a la selección de cultivares para producción difiere entre el maiz dulce procesado y el maiz de campo. Nosotros proponemos un diccionario que contiene 52 características primarias que influyen sobre la selección de cultivares para producción y que son económicamente importantes para la industria del maiz dulce en Florida. Se incorpora un grupo adicional de 61 características secundarias en el diccionario para ampliar el proceso de descripción, pero la mayoría de éstas no son económicamente importantes. Tanto las características primarias como secundarias están ordenadas en el diccionario en base a morfología, fisiología y respuesta a la presión biótica. Por propósitos logísticos, las 52 caracteristicas primarias fueron arregladas en subjuegos de cuatro a diez caractetísticas que son medidas durante los varios estadios de la ontogenia del cultivo. Estos incluyen plántula, inforescencia, cosecha de campo, predeshoje del elote, evaluación de la mazorca, y la fase de evaluación de plagas y enfermedades. La biología de las enfermedades y de las plagas de insectos varía en severidad dependiendo de la localidad, la estación de producción, los patrones de cosecha regionales y las prácticas de manejo corrientes. Las características de resistencia que son de primaria importancia en algunos casos, pueden ser de secundaria importancia en otros. Ninguna de las características secundarias fueron asignadas para medirse en estos subjuegos logísticos, pero podrían ser incluidas cuando fuera necesario.

INTRODUCTION

The corn (*Zea mays* L.) industry in Florida emphasizes the production of sweet corn. Over the last decade this industry has expanded and matured statewide. Its market orientation is primarily interstate with secondary emphasis on an emerging foreign export market. The crop is valued at about $100 million annually. Major production regions are located on the organic soils of the Everglades Agricultural Area and the Lake Apopka region in central Florida. Other important production areas include southern Dade county, north Florida, and the coastal zones of southeast Florida. In contrast to sweet corn, the Florida field corn industry has contracted over the last decade. Production is generally restricted to the panhandle and north Florida. The majority of Florida field corn is processed as feed grain for livestock and poultry with a small portion ensilaged. This crop is used locally and in the southeastern U.S., but Florida remains a net importer of field corn products (T.D. Hewitt, pers comm.).

The Florida sweet corn industry is unique because it is

Table 1: Comparison of Morphological and phenological traits of common sweet corn cultivars grown in Florida.

Plant Height (cm)

Cultivar[z]	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	162.8 ± 4.6	160.5 ± 4.3	161.8 ± 7.4	172.7 ± 3.6	179.3 ± 1.8	176.0 ±10.7
'UFY7'	184.4 ± 2.0	178.3 ± 4.1	181.4 ± 5.6	184.7 ± 4.1	183.6 ± 2.0	184.1 ± 9.4
'SS8801'	175.5 ± 8.4	179.8 ± 2.8	177.8 ±10.2	189.2 ± 4.6	203.0 ± 1.5	196.3 ± 6.1
'SS8701'	167.4 ± 3.1	168.2 ± 3.3	167.6 ± 5.3	170.2 ± 5.3	184.7 ± 1.3	177.6 ± 7.1
'SS8102'	167.9 ± 4.3	146.8 ± 9.7	157.2 ±13.0	177.3 ± 3.9	187.2 ± 1.8	182.4 ± 5.3
'SS8208'	157.4 ± 3.1	156.7 ± 2.8	157.2 ± 5.1	170.9 ± 3.8	201.4 ± 1.8	186.2 ± 5.8

Ear Height (cm)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	40.6 ± 2.3	37.3 ± 2.0	39.1 ± 3.8	43.2 ± 3.3	52.3 ± 2.0	47.8 ± 5.3
'UFY7'	56.6 ± 0.8	47.8 ± 3.3	50.8 ± 4.1	48.3 ± 2.8	50.8 ± 1.5	49.5 ± 5.3
'SS8801'	54.1 ± 3.8	51.3 ± 2.5	52.8 ± 5.3	49.0 ± 0.8	62.5 ± 0.5	50.9 ± 1.3
'SS8701'	55.6 ± 1.5	46.2 ± 1.5	50.8 ± 2.8	50.8 ± 3.3	56.6 ± 1.3	54.1 ± 4.6
'SS8102'	52.3 ± 3.3	43.2 ± 3.1	47.8 ± 5.3	49.5 ± 2.0	60.2 ± 1.3	54.9 ± 3.3
'SS8208'	41.7 ± 3.1	40.6 ± 2.5	41.2 ± 4.8	40.6 ± 4.0	596.1 ± 0.5	50.6 ± 5.1

Flag Length (cm)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring average
'SS7210'	11.7 ± 1.8	7.6 ± 1.0	9.7 ± 2.3	6.6 ± 1.3	8.4 ± 0.5	5.1 ± 1.8
'UFY7'	12.7 ± 1.3	8.4 ± 0.8	10.9 ± 1.8	8.6 ± 1.8	8.4 ± 0.5	8.6 ± 4.3
'SS8801'	14.5 ± 1.5	7.6 ± 1.0	11.2 ± 2.0	13.2 ± 1.5	14.0 ± 0.8	13.7 ± 2.0
'SS8701'	18.5 ± 3.1	9.4 ± 0.8	14.0 ± 3.3	13.7 ± 1.5	11.9 ± 2.0	12.7 ± 3.8
'SS8102'	14.0 ± 1.0	3.3 ± 0.5	11.2 ± 2.0	8.9 ± 1.3	10.9 ± 0.3	9.9 ± 1.5
'SS8202'	18.5 ± 1.8	8.4 ± 1.3	14.0 ± 2.3	14.0 ± 1.5	13.5 ± 0.8	3.7 ± 2.0

Pecent Second Ear

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	29.3 ± 10.1	7.5 ± 3.3	18.4 ±12.1	14.2 ± 4.3	10.0 ± 4.4	12.1 ± 9.3
'UFY7'	70.7 ± 5.5	52.2 ± 10.7	61.5 ±14.5	27.5 ± 9.8	8.3 ± 1.0	17.9 ±17.9
'SS8801'	49.3 ± 8.7	47.5 ± 9.9	48.4 ±15.6	27.5 ± 3.3	60.0 ± 6.7	43.8 ±12.2
'SS8701'	36.4 ± 5.5	50.8 ± 8.2	43.6 ±11.8	6.6 ± 2.7	21.7 ± 5.8	28.3 ±10.7
'SS8102'	56.4 ± 8.9	31.7 ± 9.5	44.0 ±15.4	27.5 ± 6.4	60.0 ± 12.0	43.8 ±22.3
'SS8202'	40.7 ± 8.0	71.7 ± 6.5	56.2 ±12.0	14.2 ± 6.0	68.3 ± 6.7	41.3 ± 3.8

Days to Maturity

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	78.1 ± 1.9	78.5 ± 1.6	78.3 ± 2.8	73.3 ± 1.5	75.7 ± 0.4	74.5 ± 1.9
'UFY7'	78.4 ± 1.8	80.2 ± 2.3	79.2 ± 3.5	75.8 ± 1.1	76.3 ± 0.2	76.05 ± 1.1
'SS8801'	86.7 ± 2.5	81.2 ± 1.9	84.0 ± 3.7	79.0 ± 1.1	76.3 ± 0.4	77.65 ± 1.5
'SS8701'	84.7 ± 1.7	80.0 ± 1.8	82.4 ± 3.0	76.6 ± 1.2	76.7 ± 0.2	76.65 ± 1.5
'SS8102'	80.3 ± 1.8	79.2 ± 3.0	79.8 ± 3.2	76.0 ± 1.1	76.0 ± 0.0	76.0 ± 1.4
'SS8202'	82.7 ± 2.0	78.7 ± 1.8	80.7 ± 3.1	75.8 ± 1.0	77.0 ± 0.0	76.4 ± 1.3

Days to Tassel

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	55.4 ± 1.4	54.3 ± 2.8	54.9 ± 3.8	53.2 ± 0.5	55.0 ± 0.7	54.1 ± 1.2
'UFY7'	54.6 ± 0.6	57.7 ± 3.0	56.2 ± 3.7	55.0 ± 0.3	59.0 ± 0.3	57.0 ± 1.0
'SS8801'	54.4 ± 1.9	60.0 ± 2.9	57.2 ± 4.2	59.5 ± 0.3	59.7 ± 0.2	59.6 ± 0.5
'SS8701'	57.0 ± 1.0	58.7 ± 2.9	57.9 ± 3.8	57.3 ± 0.5	60.7 ± 0.2	59.0 ± 0.7
'SS8102'	54.9 ± 0.8	57.8 ± 3.2	56.4 ± 3.8	56.7 ± 0.6	59.7 ± 0.4	58.2 ± 1.0
'SS8202'	57.3 ± 0.9	58.7 ± 3.0	58.0 ± 3.8	57.7 ± 0.6	61.3 ± 0.5	59.5 ± 1.2

[z]'SS7210' and 'UFY7' are yellow cultivars from Abbott & Cobb Seed Co. and University of Florida, respectively. 'SS8801' and 'SS8701' are white, while 'SS8102' and 'SS8202' are bicolor types from Abbott & Cobb Seed, Co.

almost exclusively based on the *sh2* endosperm gene and used entirely for the fresh market rather than processed.

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These *sh2* cultivars exhibit several outstanding attributes, primarily elevated sugar levels, extended shelf life, and consumer preference (Showalter and Miller, 1962; Wolf, 1962). Prior to 1980, sweet corn production was based on the *sugary 1(su1)* endosperm gene, but by the mid-1980's most of the Florida industry had converted to cultivars based on the *shrunken 2 (sh2)* gene. This conversion began with the release of 'Florida Sweet' (Wolf and Showalter, 1974) and 'Florida Staysweet' (Wolf, 1978). Additionally, the Florida sweet corn industry is dependent on the market advantage derived from "off-season" production, which begins in south Dade county in the early fall and moves northward as temperatures increase in the spring. As temperatures cool in the autumn production begins a southward move. Production is nearly continuous except for the hot summer months, when the temperate regions control the market.

Objective descriptions of corn cultivars primarily focus on traits important to field corn (USDA, 1992) and processed sweet corn (Kaukis and Davis, 1986). On balance, these descriptive lists are remarkably similar, but each features a set of traits unique to the given commercial use. Among the breeding programs directed at the development of fresh market cultivars, various evaluation criteria have evolved. These descriptors are similar, and reflect a consensus among *shrunken 2* sweet corn breeders. Additionally, these descriptive criteria partially overlap processor and field corn evaluation criteria. In general, the objective description of a cultivar's morphology is similar, as is the molecular/protein profile. The importance of diseases and pests, along with traits related to biotic stress are consistently recognized in the descriptive process. But, regional and seasonal differences in the environment shift the emphasis placed on a given pest. Harvest methodology and packaging also dictate the emphasis placed on a particular trait. For hand harvested sweet corn, traits of importance to growers include ear height, ear detachment (snap), husk flag length, and tillering. These traits help determine the ease and speed of harvest operations, while shank length and ear dimensions affect crate count. Regardless of these differences, the Florida ideotype tolerates minimal variation for traits such as silk and tassel color or endosperm type.

Our purpose is to develop a dictionary of descriptive traits important to sweet corn breeders, crop consultants and growers in subtropical environments; and to illustrate some differences obtained across environments. Specific emphasis is given to the evaluation of fresh market *shrunken 2* cultivars and breeding lines. This dictionary is divided into a set of primary traits, (i.e. those with economic value) and a set of secondary traits that improve the accuracy of description, but have limited economic value. Initially, we group traits consistent with plant physiology, phenology, gross morphology, and reaction to diseases and pests. Trait expression varies over the life cycle of the crop, so subsets of four to ten primary traits are grouped for measurement in the seedling, tassel, pre-harvest, field harvest, pre-husk, the husked ear, phases along with the disease and pest resistance aspects of evaluation. This grouping of traits is based on chronological expression, serves the logistic needs of the breeding program, and aims to improve the efficiency and quality of data collection. Secondary traits are not generally included in this activity, but rather are reserved for final evaluation or PVP/Patent documentation. Whenever possible, the actual measurement of a trait is preferred over subjective scales, although these scales are often more practical and reasonably accurate.

METHODS

Experiment Design and Yield Estimation

Sweet corn yield trials have been routinely conducted in Florida by private and public research programs. Results for sweet corn and a number of crops are collated and published regularly (Marvel and Guzman, 1970; Kostewiczy and Shumaker, 1975; Basset and Montelaro, 1980; White, 1982; Lazin, 1983; and Maynard, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993). Most of the trials are randomized complete block designs with three to five replicates of differing size and dimension. Little effort has been expended to determine the optimum plot size, shape or number of replicates appropriate for Florida sweet corn yield trials. Most small plot trials are configured with three-row or four-row experimental units where the outside rows serve as buffers. One practice in the Everglades Agricultural Area uses three row plots 10.6 m (35.0 ft) long with plants spaced 20 cm (8 in) apart on 76.5 to 91.5 cm (30-36 in) rows resulting in a stand count of about 54,300 to 64,500 plants per hectare (21,800-26,000 plants per acre). Plots are mostly hand planted and thinned to insure uniformity. An 8.85 m (29.0 ft) portion of the central row on the 91.5 cm row spacing is equivalent to 1/1235 of a hectare (±1/500 acre) and estimates yield from an original stand expectation of 44 plants. A four-row plot is a common modification of this practice. Prior to harvest a mature plant count (MPC) in the center row is used to estimate plant density and theoretical maximum yield, assuming one marketable ear per plant. The difference between the MPC and the original expected stand count estimates attrition over the entire crop cycle, and provides anecdotal information on a test hybrids general response to environmental stress. Additionally, from the central row a total ear count and ear weight are recovered. Following the collection of these data, ears are graded into the fancy and extra fancy classes with all others considered culls. These marketable ears are counted and weighed. Yields expressed in crates per unit area are estimated using a conversion factor of 60 ears per crate, and divided by the theoretical yield to compute a test hybrid efficiency. Frequently, differences occur in crop morphology, ear quality and yield between the fall and spring seasons (Table 1&2). These seasonal differences are not always consistent across cultivars, but trends do guide the choice of cultivars. Likewise, genotype X environment interactions influence cultivar performance across locations and planting dates within the same region and season. Because of these specific environments and the market demand for quality the Florida sweet corn industry presently relies on between 30 to 50 cultivars.

With just over 40 traits under evaluation the use of an array of standard cultivars that exhibit expression at the range limit of each trait is impractical. The use of one or a few familiar standards is a more economical approach. It is essential to include the predominate cultivars in a given region or planting period, but historical standards such as 'Florida Staysweet' and disease resistance lines serve as valuable references. Breeding programs or yield trials that focus on a few specific traits would use standard cultivars, original parental lines, or base populations appropriate to that breeding objective. Subjective performance scales based on ratings of 1 to 5, or 1 to 9 with the higher number indicative of "better" or "best" performance are routinely used. However, disease and other pest rating scales tend to be the reverse, with higher values being indicative of severity or increased levels of infestation or infection.

Stand Establishment

The use of *sh2* endosperm has had an enormous impact on the horticultural quality and post-harvest physiology of fresh market sweet corn. But this advantage is partially offset by agronomic problems related to crop establishment and seedling vigor. Reduction in seed vigor of *sh2* based cultivars is related to carbohydrate metabolism in the seed, and is further exacerbated by increased susceptibility to soil borne pathogens (Boyer and Shannon, 1982; Styer et al., 1980; Styer and Cantiliffe, 1983). In the three to four weeks following planting, three traits are used to assess stand quality, including:1) seedling stand count; 2) seedling vigor, and 3) uniformity. Seedling stand count provides the grower with a preliminary estimate of plant population, and information on the difference between germination percentage and actual emergence. Commonly taken at the 2-3 leaf stage, this difference is measured as an emergence percentage of the material planted. A small difference reflects a genotype's ability to resist or tolerate a number of abiotic and biotic stresses typically encountered during stand establishment in sub-tropical soils. Vigor and uniformity are rated on a subjective scale, usually 1 to 5 or 1 to 9, with the intermediate rating indicative of average acceptable performance. Vigor and uniformity are rated at about the third to fifth leaf stage. There is anecdotal evidence that a lack of uniformity at the seedling stage may carry through to the maturing crop.

Phenology

Crop development is divided into vegetative and generative phases. From the Planting Date (PD) to the date of 50% emergence (DOE) estimates Days to Emergence (DTE). The time from the date of 50% emergence to the date of 50% silk emergence (Date of Silking:DOS) on the top ear and the initiation of anthesis on 50% of the tassels (Date of Tassel:DOT) measure the Days to Silk (DTS) and Days to Tassel (DTT), respectively. In some breeding programs, DTS and DTT are estimated from the planting date with a four-day constant used to approximate DTE. Observations for emergence continue for three to seven days after planting under most Florida conditions, while tassels and silks are expressed anywhere from 40 to 65 days after planting for most cultivars and germplasm adapted to the Florida environment. In Florida's subtropical/tropical environments, the expression of silk and tassels are commonly synchronized, but tasseling may precede silking by one to a few days, particularly in the fall. The duration of the generative phase extends from 50% silk emergence (DOS) to milk or roasting stage (Date of Harvest: DOH), and is denoted as the Days to Harvest (DTH). Generally, 21 days post-pollination is the estimate used to predict harvest time, but this value is strongly influenced by the accumulation of heat units. An average range of 17 to 26 days is common in Florida given the current production cultivars (Table 1). The fifth phenological trait is the Days to Maturity (DTM), measured from the planting date (PD) to the date of harvest (DOH).

The fall crop is planted in the late summer, grown with decreasing temperature averages and is harvested in late fall and early winter. The spring crop is planted in the cool weather and matures with increasing temperature averages. Because the rate of heat accumulation is reversed from fall to spring, the duration of the vegetative phase in the fall crop is sometimes compressed relative to spring crop, while the generative phase may be extended in fall production relative to the spring production crop. This difference in the generative phase appears small, while general differences in DTM indicate that the fall crop is delayed from three to six days for a sample of commonly grown cultivars in the Everglades Agriculture Area (Table 1).

Heat unit or growing degree days are rarely used to characterize the ontogeny of sweet corn in Florida; these methods are more important to processed sweet corn industry where harvest schedules influence the quantity of product entering the processing facility. The simplest heat unit equation is based on the average daily temperature and a base temperature, and computed as follows:

$$H.U. = \sum_{i=1}^{n} \{ (T_{max} - T_{min})/2\}^{i} - T_{base};$$

where: T_{max} and T_{min} are the daily temperature maximums and minimums measured over the duration of a given growth stage as the days (i) run from 1 to n; and T_{base} is fixed at 10°C. A modification of this method sets a default for T_{max} and T_{min} at 30° and 10°C, respectively, and is called the 30-10 index (Shaw, 1988 and included references). Other methods such as the Ontario system (Brown, 1969) compute an adjusted T_{max} and T_{min}, or Arnolds (1959) reciprocal regression concurrently estimates heat units and a T_{base}.

Stalk and Leaf Traits

There are over 20 measurable traits with respect to stalk and leaf morphology, but only a few are of primary importance to Florida sweet corn producers (Appendix 1). Stalk quality estimates resistance to lodging and is rated on a subjective scale, as follows: 1) weak and thin stalks, susceptible to lodging; 2) poorly-braced with some bending and slightly lodged; 3) medium thick stalk, no lodging with

Table 2: Comparison of Morphological and phenological traits of common sweet corn cultivars grown in Florida.

Length (cm)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	18.3 ± 0.0	18.3 ± 0.1	18.3 ± 0.5	19.3 ± 0.0	18.5 ± 0.0	19.1 ± 0.5
'UFY7'	17.3 ± 0.1	18.0 ± 0.2	17.8 ± 0.5	17.8 ± 0.1	17.8 ± 0.1	17.8 ± 0.6
'SS8801'	17.8 ± 0.1	18.0 ± 0.1	18.0 ± 0.3	19.3 ± 0.2	18.3 ± 0.4	18.8 ± 0.8
'SS8701'	18.5 ± 0.2	17.5 ± 0.1	18.0 ± 0.5	18.8 ± 0.1	17.3 ± 0.3	18.0 ± 0.5
'SS8102'	18.3 ± 0.1	19.1 ± 0.2	18.8 ± 0.5	19.8 ± 0.1	19.3 ± 0.1	19.6 ± 0.4
'SS8202'	17.3 ± 0.1	17.3 ± 0.1	17.3 ± 0.3	18.5 ± 0.1	18.5 ± 0.2	18.5 ± 0.5

Width (cm)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	4.2 ± 0.0	4.7 ± 0.0	4.6 ± 0.4	4.8 ± 0.1	4.7 ± 0.0	4.8 ± 0.1
'UFY7'	4.5 ± 0.0	4.5 ± 0.0	4.5 ± 0.1	4.7 ± 0.0	4.5 ± 0.0	4.6 ± 0.1
'SS8801'	4.6 ± 0.0	4.4 ± 0.0	4.5 ± 0.1	4.6 ± 0.0	4.4 ± 0.0	4.5 ± 0.1
'SS8701'	4.9 ± 0.0	4.7 ± 0.0	4.9 ± 0.1	4.9 ± 0.1	4.7 ± 0.1	4.8 ± 0.2
'SS8102'	4.5 ± 0.0	± 0.0	4.5 ± 0.1	4.5 ± 0.0	4.4 ± 0.0	4.8 ± 0.1
'SS8202'	4.7 ± 0.0	4.6 ± 0.0	4.6 ± 0.1	4.6 ± 0.0	4.6 ± 0.1	4.6 ± 0.1

Shank (cm)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	3.1 ± 0.0	3.4 ± 0.2	3.2 ± 0.5	4.2 ± 0.2	3.0 ± 0.5	3.6 ± 0.9
'UFY7'	3.0 ± 0.2	1.9 ± 0.3	2.5 ± 0.8	3.6 ± 0.4	4.1 ± 0.3	3.8 ± 1.0
'SS8801'	5.3 ± 0.2	3.0 ± 0.4	4.1 ± 1.0	3.4 ± 0.2	4.2 ± 0.0	3.8 ± 0.7
'SS8701'	4.3 ± 0.0	3.8 ± 0.4	4.1 ± 1.2	3.6 ± 0.3	3.4 ± 0.6	3.5 ± 1.3
'SS8102'	4.9 ± 0.4	4.2 ± 0.3	4.6 ± 1.1	5.5 ± 0.2	4.1 ± 0.9	4.8 ± 1.6
'SS8202'	5.7 ± 0.2	6.2 ± 0.1	5.9 ± 0.7	5.7 ± 0.2	3.0 ± 0.6	4.3 ± 1.2

Percent Tip Blanking

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	50.0 ± 6.3	67.7 ± 7.7	58.9 ± 25.2	46.7 ± 7.2	90.0 ± 3.3	68.3 ± 18.3
'UFY7'	0.0 ± 0.0	10.0 ± 2.8	5.0 ± 6.8	18.3 ± 3.2	0.0 ± 0.0	9.2 ± 7.9
'SS8801'	17.1 ± 2.4	46.0 ± 6.6	31.6 ± 17.4	36.6 ± 61.1	70.0 ± 3.3	53.3 ± 16.1
'SS8701'	55.0 ± 6.2	65.0 ± 3.3	60.0 ± 16.2	61.7 ± 4.9	73.3 ± 3.8	67.5 ± 13.7
'SS8102'	8.3 ± 1.6	15.5 ± 3.0	11.9 ± 5.9	3.3 ± 1.4	6.7 ± 3.8	5.0 ± 7.5
'SS8202'	58.3 ± 6.1	42.2 ± 6.0	50.3 ± 20.1	48.3 ± 7.7	0.5 ± 0.0	24.4 ± 18.9

Tip Length (cm)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	2.1 ± 0.3	2.8 ± 0.2	2.5 ± 0.8	1.7 ± 0.0	1.2 ± 0.1	1.5 ± 0.7
'UFY7'	0.0 ± 0.0	0.3 ± 0.1	0.1 ± 0.2	1.2 ± 0.2	0.0 ± 0.0	0.6 ± 0.4
'SS8801'	0.9 ± 0.2	2.4 ± 0.1	1.7 ± 0.4	2.0 ± 0.3	0.9 ± 0.1	1.5 ± 0.7
'SS8701'	2.1 ± 0.2	2.1 ± 0.0	2.1 ± 0.4	3.0 ± 0.2	1.0 ± 0.8	2.0 ± 0.5
'SS8102'	0.5 ± 0.1	1.3 ± 0.2	0.9 ± 0.5	0.1 ± 0.1	0.3 ± 0.2	0.2 ± 0.3
'SS8202'	2.0 ± 0.1	1.8 ± 0.2	1.9 ± 0.5	1.4 ± 0.2	1.4 ± 0.0	1.4 ± 0.4

Efficiency

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	.79± .01	.47± 0.03	.63± 0.09	.80± .02	.74± .02	.41± 0.05
'UFY7'	.83± .01	.44± 0.02	.64± 0.05	.68± .03	.52± .02	.34± 0.15
'SS8801'	.59± .04	.52± 0.03	.56± 0.13	.70± .04	.48± .02	.59± 0.10
'SS8701'	.58± .04	.52± 0.01	.55± 0.11	.54± .03	.38± .03	.27± 0.09
'SS8102'	.91± .01	.52± 0.01	.72± 0.04	.89± .01	.62± .05	.76± 0.09
'SS8202'	.58± .03	.45± 0.04	.52± 0.11	.53± .02	.55± .01	.54± 0.05

Yield (cwt)

Cultivar	Fall 1991	Fall 1992	Fall Average	Spring 1992	Spring 1993	Spring Average
'SS7210'	4268.4 ± 104.3	2658.1 ± 163.3	3465.5 ± 485.4	5216.4 ± 149.7	4445.3 ± 249.5	4830.8 ± 567.0
'UFY7'	4245.7 ± 68.0	2145.5 ± 136.1	3197.9 ± 376.5	3139.4 ± 148.8	2712.5 ± 362.9	3320.4 ± 725.8
'SS8801'	2735.2 ± 181.4	2145.5 ± 77.1	2358.7 ± 521.6	3317.2 ± 251.7	2894.0 ± 86.2	3107.2 ± 635.0
'SS8701'	3252.3 ± 140.6	1955.0 ± 63.5	2603.7 ± 385.6	2907.6 ± 194.1	2132.0 ± 217.7	4771.9 ± 607.8
'SS8102'	4935.2 ± 86.2	2649.0 ± 81.6	3792.1 ± 290.3	5252.7 ± 95.3	4286.5 ± 412.8	4771.9 ± 753.0
'SS8202'	2640.0 ± 90.7	1714.6 ± 140.6	2177.3 ± 417.3	2694.4 ± 79.8	3606.1 ± 344.7	3152.5 ± 630.5

[z] 'SS7210' and 'UFY7' are yellow cultivars from Abbott & Cobb Seed, Co. and University of Florida respectively. 'SS8801' and 'SS8701' are white, while 'SS8102' and 'SS8202' are bicolor types from Abbott & Cobb Seed, Co.

some bending; 4) upright with no lodging or bending, well-braced, thick stemmed; 5) upright and robust "strong". Lodging ratings are commonly estimated in the absence of wind, and are frequently based on an expected response of the plant's stalk architecture. Inaccuracies can arise because cultivars with more pliable or flexible stalks may tolerate wind stress, but not appear robust or "strong". Three additional stalk traits are important to Florida sweet corn production, including the average plant height, tiller number and tiller height. Although, tillers are undesirable, occasional short tillers are within the scope of the Florida ideotype, but a profusion of tillers slows the pace of field harvesting crews. Tiller height and frequency appears to increase with increased fertility. These traits are measured after tassel expression but before harvest. A number of secondary traits associated with the stalk include tiller erectness, stalk color, stalk thickness at the top ear node, number and average length of nodes between tassel and top ear, number of nodes with brace roots, and brace root color.

Most leaf traits are of secondary importance and are used mostly to improve a description's accuracy. These include leaf angle on the upper half of the plant, leaf color, leaf length and width of the leaf subtending the top ear, total leaves at tassel, average number of marginal waves per leaf, longitudinal creases, and sheath pubescence. Florida cultivars range from about 1.7 m to 2.1 m tall with 5 to 8 leaves above the top ear. The fall crop tends to produce plants that are shorter (Table 1). Ear leaf length mostly ranges between 60 cm and 90 cm, and is set at an angle of ≥45°. Leaves are not rigid and commonly "break" with the distal one third to one half of the leaf blade pendulant. This facile leaf structure decreases canopy porosity, influences disease development, and pesticide and light penetration.

Husk, Ear, Cob, Kernel and Tassel Traits

Reproductive traits are measured both pre-and post harvest. Ear traits measured prior to harvest include the height of the top ear and the second ear count. Ear height measures the placement of the top ear from ground level to the node of attachment. Top ear heights from 50 cm (20") to 75 cm (±30") above the ground are preferred for hand-harvest operations, with greater tolerance allowed for machine harvest. Ears attached below 50 cm accelerate fatigue in field harvest crews; knee height is an acceptable rule of thumb for minimum ear placement. In general the fall crop is not only shorter but the ear placement is also lower. On most plants a second and occasionally a third ear develop but are mostly rudimentary. A second ear may mature, but is usually later, shorter and has poor confirmation. These differences are related to the genotype and seasonal differences in temperature and daylength. Ear angle is of secondary importance because most *sh2* cultivars grown in Florida have a top ear angle of 15 to 30° from the stalk at the eating stage.

At maturity, the number of ears harvested in the sample row are counted and the ease of detachment, sometimes called "snap" or "pull", recorded. Detachment is mostly rated on a 1 to 3 scale as easy, medium or hard, with "very easy" and "very hard" categories expanding the scale to five categories. Three other primary husk traits evaluated just prior or just after harvest include: husk extension beyond the tip of the cob; tightness of the husk beyond the tip measured on a 1 to 5 scale from very tight to very loose; and average length of the flag leaves. Prior to husking, the marketable yield traits mentioned previously are collected as the average peduncle (shank) length and the percent of cobs extruded from the husks (outs). Shank length is more critical to hand harvest operations where wire-bound crates (≥1.09 bu) must be packed with a set number of ears ranging from 48 to 60. Shank lengths of ≤ 7.5 cm are preferred in Florida. Cultivars with longer shanks pack fewer to the crate and may require hand harvesters to break peduncles to meet a minimum crate count. Extruded ears often have green tips, which reduces market acceptance, increases susceptibility to shipping damage, and reduces the morphological barrier to insect damage. Husk tightness is another primary trait that estimates the force required to strip the husk from the ear, and is measured on a 1 to 5 scale that ranges from very loose to very tight. Husk tightness is a function of husk number, overlap, and width. Compared to the tight husked insect resistant field corn types (Wiseman, 1990) sweet corn cultivars are relatively loose, but excessive tightness increases the difficulty consumers may encounter when shucking. An array of secondary husk and related traits include: husk color at market stage, dry husk color and ear angle at seed maturity; husk number, taper, length, width, overlap, and the number of flags and shank nodes along with the length and width of the ears in the husk. Silk traits such as color, silk duration, and extruded silk length are of secondary importance and fairly uniform for most of the sweet corn industry.

Traits associated with the culinary quality of the husked ear are perhaps the most critical to the consumer, and consequently influence the stability and expansion of a sweet corn market. Three taste traits are used to summarize roasting quality (Appendix 1). Flavor is measured as: 1) starchy; 2) flat, mildly starchy; 3) acceptable sweetness and flavor; 4) good flavor; or 5) very sweet. Pericarp quality is indicative of kernel tenderness and rated on the following scale: 1) unacceptable; 2) slightly tough; 3) acceptable; 4) tender; or 5) very tender. Texture measures kernel consistency as: 1) starchy; 2) watery to starchy; 3) smooth to watery; 4) smooth; or 5) creamy. Analytical methods that more accurately estimate the percentage of sugars, the ratio of sugars to the polysaccarides, (Brecht and Sargent, 1989), develop sugar profiles, or measure pericarp resistance and thickness are available (Brewbaker, 1988). Although, these subjective measures of quality are perhaps less accurate, they provide a cost effective, rapid and reasonable portrait of a cultivar's culinary quality. Eating quality is based on the raw ears sampled at the time of harvest. Usually a handful of ears are chosen from the adjacent buffer rows with two or three evaluators attempting concurrence.

Ear quality traits are also summarized with objective criteria. The physical attributes of the ear are based on a ten ear sub-sample randomly selected from the total of marketable ears and aligned on a metered board. Ear dimensions include the average ear length along with the minimum and maximum lengths recorded in the sub-sample. Average ear width is concurrently recorded, as is the number of ears with unfilled tips and the average length of these tips. From these ten ears, the majority row count of marketable ears is also estimated along with a minimum and maximum row count found in the sub-sample (Appendix 1). Marginal differences in ear length and width are common between spring and fall crops, but no consistent differences in either tip blanking or the portion of the blanked tip is attributed to season (Table 2). Ear dimension standards for Florida production set a minimum acceptable average ear length of 15 cm and up to 19 cm with maximum uniformity. Preferred ear width averages should range between 4 and 5 cm, while majority row counts of 16 or 18 are most desirable. Standard practice among Florida growers is to strive to exceed the U.S.D.A. grade standards.

Row quality, ear shape and general appearance are subjective traits associated with ear quality, and commonly measured on a 1 to 5 scale. The values assigned to row quality include: 1) Nearly all rows dropped or broken, and strongly spiralled; 2) mostly spiralled with dropped or broken rows; 3) slightly spiralled or broken rows; 4) mostly perfect rows; and 5) perfect rowing. Ear shape is rated as follows: 1) ears strongly tapered at both ends and/or bent; 2) taper at both ends of the ear; 3) cylindrical ear strongly tapered at the tip; 4) cylindrical ear tapered at the tip; and 5) cylindrical ear from butt to tip. The general appearance rating is the most subjective of all ear quality traits and attempts to integrate all ear quality traits into a single measure. General appearance is scaled from 1 to 5, with 5 being "best".

Cob traits of secondary importance include cob color, cob width at the midpoint and cob strength as measured on a weak to strong scale. In Florida, the accepted cob color is white, but width and strength are somewhat flexible. Cobs are also expected to be straight with a round transect; out of round and bent cobs reduce ear quality and confirmation. Kernel traits include those traits related to consumption and agronomic quality. The Florida sweet corn industry is based on the *Shrunken 2 (sh2)* endosperm, but newer breeding lines with the *sh2/sh2, su1/su1* and *sh2/sh2, su1/-* genotypes are being introduced. These double mutants have elevated sugar levels, but are plagued by a series of stand establishment problems (Brecht *et al*, 1990; Kent Keim, Pers. Comm.). In addition to the *sh2* and *su1* endosperm types, a number of other endosperm mutants are typically used in the sweet corn industry; these include the *sugary enhancer (se)* gene, which is combined with the *su1* gene, and the *Brittle 1 (bt1)* gene, which is the endosperm type for several cultivars in the Asian and Pacific markets. Other endosperm mutant genes are avaiable but rarely used (Kaukis and Davis, 1986).

Seed color traits for Florida including pericarp, aluerone and endosperm only vary between yellow and white plus bicolor. Kernel dimension including depth, width, and length of the fresh kernels influence appearance of fresh sweet corn, while growers of processed sweet corn are interested in kernel depth, kernel compression, and soluble solids because they influence economic yield. Agronomic traits important to the seed industry include test weight, seed grade and yield of the maternal parent.

Insect Pests

Damage from insect pests is a major concern in Florida sweet corn production, because unlike field corn, few if any of the current cultivars exhibit satisfactory levels of insect resistance. Several moth species from the family Noctuidae are year round pests that require control with expensive pesticides. The fall armyworm, *Spodoptera frugiperda* (J.E. Smith) is the primary pest of sweet corn in Florida (Foster, 1989). The corn earworm, *Helicoverpa zea* (Boddie) presents less of a problem, but is important in other subtropical locations (Mitchell, 1978). This is reversed from twenty years ago when corn earworm was cited as the major corn pest in Florida (Janes, 1973). Both insects concentrate their feeding on expanding leaf and tassel tissue within the whorl. After tassel push, feeding is concentrated in the ear with larvae entering through the silk channel, or directly through the husk with larger larvae. Resistance by fall armyworm and corn earworm to commonly used pesticides has increased steadily (Yu, 1992), indicating a need for host plant resistance. Additional Lepidoptera insects such as the beet armyworm (*S. exigua* [Hubner]), and *S. latisfascia* (Walter) are occasional pests of sweet corn (Foster, 1985) as general herbivores. Several species of cutworms also attack and damage seedlings by cutting the emerging plants off at the soil surface. Sweet corn in Florida is further plagued by several stalk boring insects, including the lesser cornstalk borer (*Elasmopalpus lignosellus* [Zeller]), the sugar cane borer (*Diatrea saccharalis* [F.]) (both Lepidoptera: Pyralidae) (Kelsheimer *et al*., 1950), and the corn stem weevil (*Hyperodes humilis* [Gyllenhal], Coleptera: Curculionidae) (Harris, 1960). While major outbreaks have occurred, the latter two borers are usually held in check by routine pesticide applications for the major insect pests. The lesser corn stalk borer is more of a problem in fields newly rotated from infested sugar cane and then planted without a preplant soil insecticide treatment. Feeding damage to the vascular system and roots results in poor stands, wilting, stunting, lodging, or plant death. Similar damage is caused by the larvae of several species of Elateridae and Carabidae beetles (wireworms) that feed directly on seed, seedlings, and roots (Wilson, 1946).

Corn silk flies (*Euxesta stigmatis* Loew) (Diptera: Otitidae) are an important late season pest (Kelsheimer et al., 1950); eggs are laid in the silk channel (Seal & Jansson, 1993) and emerging larvae enter the ear and feed on silk and kernels. Sap beetles (*Carophilus sp*., Coleoptera: Nitidulidae) are attracted to ears at the milk stage, and feed on the kernels (Kelsheimer *et al*., 1950). These insects are often found in association with silk fly damage. All stages of these two insects are shielded from treatments within the developing ears and are capable of ruining a crop if not treated. Many other insects are occasional pests, but can be damaging in a particular locality. These include representatives from Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Orthoptera, and Lepidoptera (Johnson, 1992). Insecticides applied for the major insect pests often keep these occasional pests below damaging levels.

Research on sweet corn insect control strategies has historically focused on improved chemical controls, and developing damage thresholds to improve the timing of pesticide applications. Sweet corn breeding programs have improved taste, shelf life, and disease resistance, but research on host plant resistance or damage rating scales for varying resistance levels is limited. Both host plant resistance and damage rating scales have been developed for the major pests of field corn, several of which are also of concern to sweet corn growers. These should be used or modified for use in sweet corn. Antibiosis-based foliar and silk resistance to caterpillar feeding has been introgressed into field corn from tropical land races (Wiseman *et al.*, 1992). Tight husked corn cultivars elevate resistance by providing a morphological barrier to ear feeding caterpillars, but may increase susceptibility to the corn silk fly (D. Seal, Pers. Comm.). However, tight husk tips and elongated husk channels among inbreds can adversely effect silk emergence, pollination, and subsequent seed production.

Feeding by naturally occuring insect populations can be evaluated with damage scales, but their non-random distribution habits and the uncertainity of attack make standardized ratings difficult to use and degrades the concurrence of results between sites and seasons. Replicated field trials should be designed to specifically evaluate resistance to insect feeding. This includes the release of laboratory reared insects onto plants to insure and regulate the timing of infestation. Insect feeding damage and resistance is evaluated after a predetermined length of time; usually 7 to 14 days for leaf feeders, 50 to 60 days for borers. Neonate larvae are placed onto specific plant structures at standardized plant growth stages (e.g., into whorls of 7 to 10 leaf stage). Leaf feeding damage by fall and beet armyworms, corn earworm, and sugar cane borer could be rated using a visual scale ranging from 0 = no visual leaf damage to 9 = large lesions and large portions eaten in several leaves (Davis *et al.*, 1992). Damage to ears by these pests could be based on percentage of ears with feeding injury on and entrance holes in husks, and feeding damage to silk, tips, and kernels. Resistance in silks to feeding injury is evaluated using a laboratory bioassay where fresh silks are incorporated into an artificial diet. Larval weights, head capsule widths, pupal weights, and adult emergence of insects reared on the diet are then evaluated (Wiseman *et al.* 1992).

Evaluation of damage due to stalk borers could be based on those used for European corn borer [*Ostrinia nubialis* (Hubner)] and southwestern corn borer [*Diatraea grandiosella* (Dyar)] (bothLepidoptera: Pyralidae) in field corn. Sugar can borer damage to the leaf sheath and collar regions where they enter the plant could be rated during trials on a visual scale ranging from 1 = no damage to 9 = extensive damage (Guthrie *et al.*, 1978). At the end of trials, the stalks could be dissected longitudinally form the tassel to the plant base, and tunneling damage on the four internodes above and below the primary ear shank could be rated from 0 to 8, equivalent to the number of internodes with tunneling (modified from Kaster *et al.*, 1991). The length of feeding tunnels in stalks (Davis and Williams, 1983) would be effective for rating lesser corn stalk borer and corn stem weevil damage because they enter the stalks at the soil level.

Wireworm damage is most critical between planting and the 7th leaf stage. Damage could be evaluated as percentage of seeds damaged or consumed, and plants killed or lodged as a result of root pruning or tunneling. We are evaluating damage ratings for corn silk fly and sap beetles using percentage of infested ears, number of silk fly pupae in the silk channel at harvest, and a visual damage scale ranging from 0 = no damage to 10 = 100% damaged kernels.

Diseases

Over 38 pathogenic disorders are reported on corn in Florida (Alfieri *et al.*, 1984). Because of the state's warm moist climates the majority of these pathogens are of fungal origin. Florida's year-round growing conditions also provide for a continual supply of susceptible host tissue and inocula for many plant pathogens. Although any one of these diseases can cause extensive losses in a given environment, there are several diseases that are consistently of economic importance to Florida sweet corn production. Fungi development is strongly influenced by temperature, and epidemiology is frequently determined by seasonal temperatures.

During the initial stages of *shrunken 2* hybrid establishment in Florida agriculture damping-off and seedling blights were frequently observed in epidemic proportions. The incidence of these seedling diseases was a major impediment to the acceptance of *shrunken 2* hybrids (Berger and Wolf, 1974). Reductions in stand and seedling vigor were typically severe when soil conditions were cool and wet, slowing the rate of germination and early growth. Although a myriad of pathogens may be responsible, *Pythium spp., Penicillium oxalicum,* and *Fusarium moniliforme* were the organisms most commonly associated with *shrunken 2* stand problems (Baird *et al.*, 1992). Initially, *shrunken 2* hybrids were thought to be more susceptible to seedling disorders, primarily due to elevated sugar levels within the seed. However, reduced early vigor of *shrunken 2* seedlings appears more important (Headrick *et al.*, 1990). Successful selection for traits such as emergence, early vigor, and uniformity during the past decade has reduced the effect of these pathogens, as have improvements in seed treatment fungicides and application technology. Present rating of stand establishment traits is assumed to provide an adequate approximation of disease tolerance. Headrick and Pataky (1991) reported that selection for factors operative in the maternal tissues of the seed, such as delayed silk senescence, might reduce stand problems and kernel infection.

Three foliar diseases are of primary importance in Florida grown sweet corn, and each is favored by different temperature regimes; therefore each predominates at separate times of the year, although they may occur simultaneously. Northern corn leaf blight (NCLB), caused by *Exserohilum turcicum* (Pass.) Leonard & Suggs (formerly known as *Helminthosporium turcicum*), is considered the most serious sweet corn disease in Florida (Guzman *et al.*, 1967). Characterized by its long, elliptical, grayish-green to tan lesions ranging from 2.5 to 15 cm in length (Shurtleff, 1980), the disease is capable of causing yield losses in excess of 50% on highly susceptible cultivars if left untreated (Sherf and MacNab, 1986). Disease development is favored by moderate temperatures (18-27 C) and long periods of leaf wetness. In Florida heavy dews are frequent and create a conducive environment for *E. turcicum* sporulation and infection. NCLB is commonly more severe in the lower canopy, and Pataky (1992) reported that yield losses could be minimized by maintaining severities below 8% in the upper 75% of the canopy.

Reactions of sweet corn hybrids to NCLB vary from highly susceptible to highly resistant. Vertical resistance is derived from four major (*Ht1, Ht2, Ht3,* and *HtN*) genes that are deployed in many of the sweet corn cultivars; partial resistance is conferred polygenically, but is not extensively used. Specific resistance conferred by the *Ht1* gene remained effective in Florida until 1979, when a new race, presumably race 1, was reported (Pieczarka, 1979). More recently, races 23 and 23N have also been detected in Florida (Pataky, 1991), although their prevalence appears to be low at the present time. Physiological specialization within *E. turcicum* emphasizes the importance of polygenic resistance in the control of NCLB (Sigulas *et al.*, 1988). Sweet corn cultivars are routinely screened for NCLB using a variety of rating schemes. Perhaps the most widely used scale is that developed by Elliott and Jenkins (1946), which rates blight on a 0.5 to 5 scale, with 5.0 representing a total defoliation and death of the plant. Standard disease assessment diagrams illustrating percent defoliation due to blight are also widely used (Pataky *et al.*, 1990). Assessments may be made on either a particular leaf, set of leaves, or on a whole-plant basis.

Southern corn leaf blight (SCLB), is caused by the fungus *Bipolaris maydis* (Nisik.) Shoemaker (formerly known as *Helminthosporium maydis*), and favors warmer temperatures (20 - 32 C) than NCLB. It is most prevalent in Florida's autumn growing season. Two races of SCLB have been reported, Race O and Race T. Since Race T is virulent only on maize with Texas male-sterile cytoplasm, Race O is the more important of the two races on sweet corn. SCLB symptoms incited by Race O are characterized by elongated lesions (2.0-6.0 X 3.0 -22.0 mm long) between the veins, with limited parallel margins and buff-to-brown borders (Shurtleff, 1980). Race O usually attacks only leaves while Race T may occur on leaves, stalks, husks, ears, ear shanks, and cobs. Lesions produced by Race T are somewhat more elliptical than those caused by Race O and often have a dark brown border. In addition to polygenic resistance, resistance to Race O may also be conferred by the recessive *rhm* gene. While Race O displays no differential reaction to hybrids with different cytoplasms, male-sterile cytoplasms other than Texas male-sterile are resistant to Race T. SCLB is rated in a manner identical to that used for NCLB.

Common rust (CR), incited by the pathogen *Puccinia sorghi* Schw., is generally considered to be a cool temperature disease and is most prevalent during Florida's spring growing season. Although usually ranked behind NCLB and SCLB, its importance has grown in the past few years. Southern corn rust (SCR) incited by *Puccinia polysora* (Underw.) is a warm temperature disease that is prevalent during the fall growing season. Although both rust pathogens produce the typical erumpent pustules on susceptible corn leaf tissue, they may be distinguished macroscopically by pustule morphology, location, and color. Mature common rust pustules are somewhat elon-gated, cinnamon to chocolate brown, and occure in approximately equal densities on both the upper and lower leaf surfaces. Southern rust pustules are typically circular, light cinnamon brown to orange, and are usually much more prevalent on the upper leaf surface (Shurtleff, 1980). Either rust may result in foliage becoming prematurely desiccated and necrotic when severe and are capable of producing significant yield reductions (Pataky, 1987a). Both generalized and specific resistance have been reported to CR and SCR. Specific resistance to CR is conferred by a series of dominant *Rp* genes (Pataky, 1987b), with reactions ranging from chlorotic to necrotic flecks . Generalized resistance to CR, occasionally referred to as "mature plant resistance", is characterized by fewer, smaller, or less productive pustules (Headrick and Pataky, 1987). Although specific resistance to SCR is also governed by single dominant genes, the incorporation of resistance to SCR into commercial hybrids lags far behind that of CR. At least nine physiological races of *P. polysora* have been described thus far (Raid *et al.*, 1988).

Rating of rust severity is commonly performed on a relative percentage basis, where 37% of the leaf area covered by pustules equals 100% (Peterson *et al.*, 1948). Following tissue necrosis, ratings may be performed on a percent defoliation basis using standard area diagrams similar to those used for NCLB and SCLB. When making selections, special attention should be paid to ear husks and flag leaves since rust pustules on the husk may result in quality reductions and potentially spread new races of rust from the southern U.S. into the temperate regions.

Although other corn diseases such as Stewart's wilt, Goss' wilt, and corn smut are considered important in other sweet corn growing regions of the U.S. (Pataky *et al.*, 1990), these diseases have historically been of little concern in Florida. Of the remaining diseases, bacterial blight incited by *Psuedomonas aveanae* Manns is the only one that occurs routinely. Symptoms appear as long linear lesions on the leaves as they emerge from the whorl, and turn brown with age. Plants in the advanced whorl stage are more susceptible, but the foliage rarely becomes infected following full expansion.

At least six insect vectored diseases are reported on Florida sweet corn, including maize stripe virus, maize mosaic virus, maize dwarf mosaic virus, maize rayado fino virus, corn stunt spiroplasma, and maize bushy stunt mycoplasma. Their incidence is usually low with a few local outbreaks leading to economic losses mostly on the southern tip of the state (Bradfute and Tsai, 1983; Niblett *et al.*, 1982). These diseases are likely contained by indirect control of their aphid, and leaf and planthopper vectors through routine insect management programs.

CONCLUSION

The typical sweet corn cultivar will require genetic modification as changes in food standards, horticultural quality, environmental regulation, agronomic practices, and cropping patterns shift or as new diseases and pests arise. Market trends indicate the traits such as ear length, tip fill, row quality, kernel color, post harvest quality and general ear confirmation and refinement will continually advance.

Taste and culinary parameters will also change, particularly if double mutants gain market share. The increased use of tray packs, partially husked ears and other novel presentations of sweet corn in the market will likely shift emphasis away from husk and flag traits and place greater importance on the aesthetics of ear quality. Agronomic practices such as plant nutrition, altered cropping systems, and other field management techniques will clearly mandate future changes in the sweet corn genotype. The architecture and design of the field corn plant may provide a model for components of future sweet corn cultivars. Morphological traits such as lodging resistance, lack of tillers, adaptation to high density planting, and a more upright leaf structure that improves light distribution could benefit the sweet corn industry. However, traits unique to sweet corn including ear angle, height and ease of detachment, along with plant height and other traits that have ergonomic qualities are not readily available in the field corn germplasm.

Perhaps the greatest change in the typical sweet corn genotype will result from the deployment of host plant resistance. As pesticide regulation intensifies the integration of pesticicde use and cultural management strategies combined with host plant resistance will expand. Both simple and polygenic based resistance to common rust and NCLB are available in many sweet corn cultivars, but the development of new races that overcome the current genetic resistance should be anticipated. Similarly, genetic control of one pathogenic disorder or insect pest will undoubtedly produce opportunities for new deleterious organisms, particularly if management/pesticide use is relaxed against the primary pest or if improved resistance to one pest is negatively correlated with another.

Additionally, broad based changes in regional production patterns will influence the epidemology and alternate host relationships in a region. Subtropical regions of the U.S. often serve as entry points for new pathogens and insects, which seems to further exacerbate our problems. Newly arrived organisms can migrate northward depending on their range of adaptation, but often do the most damage soon after introduction and prior to the build up of predatory or parasitic populations. Quarantine protocols are useful but not completely exclusive.

These probable changes imply that any list of economically important traits must be continually adjusted. The standard check cultivars that are appropriate for a given set of traits, production region, or market niche will likewise change. Corresponding alterations in objective and subjective scales will clearly occur as the market demands higher quality. These challenges will not only affect the various disciplines that conduct research on this commodity, but how sweet corn is handled commercially.

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Appendix I: A summary of primary economic traits used to evaluate shrunken 2 based sweet corn hybrids in Florida.

Trait	Computer Code	Rating Scale
Stand Establishment		
Seedling Stand Count	SSC	%
Seedling Vigor	VIG	1 to 5
Seedling Uniformity	UNF	1 to 5
Crop Phenology		
Planting Date	PD	Julian Date (JD)
Date of Emergence	DOE	JD
Date of Tassel	DOT	JD
Date of Silk	DOS	JD
Date of Harvest	DOH	JD
Days to Emergency (DOE-PD)	DTE	Days (d)
Days to Tassel (DOT-PD)	DTT	d
Days to Silk (DOS-PD)	DTS	d
Days to Maturity (DOH-PD)	DTM	d
Days to Harvest (DOH-DOS)	DTH	d
Stalk and Plant		
Stalk Quality	STK	1 to 5
Plant Height	PLT_HT	cm, in
Tiller Number	SCK_NO	count
Tiller Height	SCK_HT	cm, in
Husk, Ear and Kernel		
Height of Top Ear	E_HT	cm, in
Percent Second Ear	PCT_SE	%
Ease of Ear Detachment (snap)	SNP	1 to 5
Husk Extension Beyond the Tip	HSK_L	cm, in
Husk Tip Tightness	TIP_T	1 to 5
Husk Flag Length	FLG	cm, in
Shank Length	SHNK	cm, in
Percent Extruded Ears	OUTS	%
Husk Tightness	SHUK	1 to 5
Flavor	FLV	1 to 5
Pericarp	PCRP	1 to 5
Texture	TXT	1 to 5
Average Ear Length	EAR_L	cm, in
Minimum Ear Length	E_MN	cm, in
Maximum Ear Length	E_MX	cm, in
Average Ear Width	WTH	cm, in
Percent Unfilled Tips	PR_TIP	%
Average Length of Unfilled Tips	TIP_L	cm, in
Majority Row Count	RW_C	count
Minimum Row Count	RW_MN	count
Maximum Row Count	RW_MX	count
Row Quality	RW_QT	1 to 5
Ear Shape	E_SHP	1 to 5
General Appearance	APP	1 to 5
Diseases and Insects		
Bacterial Leaf Blight	BBLT	%, 1 to 11
Common Rust	RUST	%, 1 to 11
Northern Leaf Blight	NCLB	%, 1 to 11
Southern Leaf Blight	SCLB	%, 1 to 11
Corn Silk Fly	CSF	%, 0 to 9
Fall Armyworm	FAW	%, 0 to 9
Yield		
Mature Plant Count in Data Row	MPC	count
Total Ears Harvested in MPC	HARV_NO	count
Total Weight	T_WT	Kg, lbs
Marketable Ears in MPC	MKT_NO	count
Weight of Marketable Ears	MKT_WT	Kg, lbs
Plants per Hectare (Acre) (MPC * Plot size)	PLTS_A	count
Theoretical Yield (PLTS_A/60)	TH_YLD	crates
Actual Yield (MKT_NO * Plot Size/60)	ACT_YLD	crates
Hundred Weight (MKT_NO * Plot Size/100)	CWT	count
Efficiency (MKT_N/MPC)	EFFP	%