Investigation of characteristics and cultivation of sweet corn: A Review

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ABSTRACT: Most sweet corn varieties are hybrids which have been bred for greater vigor and higher yields. Sweet corn varieties are available in yellow, white, or bicolored types, with varying maturity dates from early to mid- to late season. Maturity dates will vary from year to year and by location depending on weather (primarily temperature). On a farm with similar rotations, soil, and management, sweet corn yield increased predictably in relation to N application rate. Eight sweet corn hybrids in 2007-2009 and nine sweet corn hybrids in 2005-2008 with conventional sweet corn (SC403) were compared. Experiments were conducted in Iran. The result in 2005-2008 was showed that three way cross 401 had the highest kernel yield with 6.04t/ha. SC403 had 5.64t/ha kernel yield. The result in 2007-2009 showed that higher kernel yields were resulted from hybrids BASIN and POWER HOUSE with 7.66 and 7.31 t/ha respectively. These hybrids had higher yield than the check (SC403) with 6.11 t/ha.

Keywords: Characteristic, hybrid, sweet corn, yield

INTRODUCTION

Sweet corn (Zea mays convar. saccharata var. rugosa also called sugar corn, dent corn and pole corn) is a variety of maize with a high sugar content. At optimum market maturity, sweet corn will contain 5 to 6% sugar, 10 to 11% starch, 3% water-soluble polysaccharides, and 70% water. Sweet corn will also contain moderate levels of protein, vitamin A (yellow varieties), and potassium. Use only the earliest varieties for late summer/early fall plantings to assure a good fall crop. Fall-maturing sweet corn will almost always be the highest quality, since cool nights.

1. Soil during fall increase sugar content Sweet corn will grow well on almost any well-drained soil, although deep, sandy loams with adequate organic matter are best. Loams and clay loams are ideal for late-maturing varieties, which require more water and nutrients.

2. Sweet corn characteristics
Sweet corn is the result of a naturally occurring recessive mutation in the genes which control conversion of sugar to starch inside the endosperm of the corn kernel. Unlike field corn varieties, which are harvested when the kernels are dry and mature (dent stage), sweet corn is picked when immature (milk stage) and prepared and eaten as a vegetable, rather than a grain. Since the process of maturation involves converting sugar to starch, sweet corn stores poorly and must be eaten fresh, canned, or frozen, before the kernels become tough and starchy (Erwin, 1951). Hybridization allowed for more uniform maturity, improved quality and disease resistance. In most of Latin America, sweet corn is traditionally eaten with beans; each plant is deficient in an essential amino acid that happens to be abundant in the other, so together sweet corn and bean form a protein-complete meal. In Brazil, sweet corn cut off
from the cobs is generally eaten with peas (where this combination, given the practicality of steamed canned grains in an urban diet, is a frequent addition to diverse meals such as salads, stews, seasoned white rice, risottos, soups, pasta, and, most famously, whole sausage hot dogs) (Kaloo et al., 1993). Similarly, sweet corn in Indonesia is traditionally ground or soaked with milk, which makes available the B vitamin niacin in the corn, the absence of which would otherwise lead to pellagra; in Brazil, a combination of ground sweet corn and milk is also the basis of various well-known dishes, such as pamonha and the pudding-like dessert curau, while sweet corn eaten directly off the cobs tends to be served with butter.

The fruit of the sweet corn plant is the corn kernel, a type of fruit called a caryopsis. The ear is a collection of kernels on the cob. Because corn is a monocot, there is always an even number of rows of kernels. The ear is covered by tightly wrapped leaves called the husk. Silk is the name for the pistillate flowers, which emerge from the husk. The husk and silk are removed by hand, before boiling but not necessarily before roasting, in a process called husking or shucking. Sweet corn was a special maize variety, differ genetically from field maize. Its kernels are tender, delicious and eaten as a vegetable in many cuisines worldwide. In contrast to traditional field corn, sweet corn crops harvested when their corn-ears just reached milky stage. Its cobs either used immediately or frozen for later use since sugar content quickly turns into starch. Several different sweet corn cultivars with many variations in their sweetness, color, and maturation grown according to the local and regional requirements. Depending upon the cultivar type, its crop can be ready for harvesting in 65-90 days. Harvesting done when free end (silk end) of the ear full, its silk has turned brown and its kernels are firm but in the milky stage. Oftentimes, farmers check the kernels by pricking them with their thumbnail to ascertain harvest timing. At 86 calories per 100 g, sugar corn kernels are moderately high in calories on comparison to other vegetables. However, fresh sweet corn has much less calories than that of in the field corn and other cereal grains like wheat, rice, etc. Their calorie chiefly comes from simpler carbohydrates like glucose, sucrose than complex sugars like amylose and amylopectin, which is a case in the cereals. Sweet corn is a gluten-free cereal and may be used safely in celiac disease individuals much like rice, quinoa, etc.

Corn is native to Central America which later introduced to the rest of the world through Spanish explorers. Genetically, sweet corn differs from the field corn by mutation at the sugary (su) locus. Its crop has achieved a major success as one of the important commercial cash crops in many tropical and semi-tropical countries. The kernels are boiled or steamed. In Europe, China, Korea, Japan and India, they are often used as a pizza topping, or in salads. Corn on the cob is a sweet corn cob that has been boiled, steamed, or grilled whole; the kernels are then eaten directly off the cob or cut off. Creamed corn is sweet corn served in a milk or cream sauce. Sweet corn can also be eaten as baby corn (Kaloo et al., 1993). If left to dry on the plant, kernels may be taken off the cob and cooked in oil where, unlike popcorn, they expand to about double the original kernel size and are often called corn nuts. A soup may also be made from the plant, called sweet corn soup. Kernel may also was dried (Stickler and Laude 1960., Williams et al 1988). Cooked sweet corn increases levels of ferulic acid, which has anti-cancer properties. Open pollinated (non-hybrid) corn has largely been replaced in the commercial market by sweeter, earlier hybrids, which also have the advantage of maintaining their sweet flavor longer. Su cultivars are best when cooked within 30 minutes of harvest. Despite their short storage life, many open pollinated cultivars such as ‘Golden Bantam’ remain popular for home gardeners and specialty markets, or are marketed as heirloom seeds. Although less sweet, they are often described as more tender and flavorful than hybrids. Early cultivars, including those used by Native Americans, were the result of the mutant su (“sugary”) allele. They contain about 5–10% sugar by weight (Kavkis et al., 1986).

All of the alleles responsible for sweet corn are recessive, so it must be isolated from other corn, such as field corn and popcorn, that release pollen at the same time; the endosperm develops from genes from both parents, and heterozygous kernels will be tough and starchy. The se and su alleles do not need to be isolated from each other. However supersweet cultivars containing the sh2 allele must be grown in isolation from other cultivars to avoid cross-pollination and resulting starchiness, either in space (various sources quote minimum quarantine distances from 100 to 400 feet or 30 to 120 m) or in time (i.e., the supersweet corn does not pollinate at the same time as other corn in nearby fields). Modern breeding methods have also introduced cultivars incorporating multiple gene types: sy (for synergistic) adds the sh2 gene to some kernels (usually 25%) on the same cob as a se base (either homozygous or heterozygous) augmented sh2 adds the se and su gene to a sh2 parent. Often seed producers of the sy and augmented sh2 types will use brand names or trademarks to distinguish these cultivars instead of mentioning the genetics behind them. Generally these brands or trademarks will offer a choice of white, bi-color and yellow cultivars which otherwise have very similar characteristics (Kavkis et al., 1986). Selecting high-yield cultivars adaptive to regional climate, is important factor in achieving the maximum efficiency in sweet corn production. Realizing the highest possible yield depends upon adequate moisture availability, soil fertility and crop
genetic capacities (Hashemi-Dezfuli et al., 2001). Sweet corn is sensitive in flowering stage to water stress (Chotena et al., 1980). Sweet corn breeding, has created the new types of sweet corn with good quality food storage capacity (Hallauer, 1993), the spread of sweet corn likely begun from Peru to Mexico, in the south-west of the United States and then begun to spread in the northern parts (Boyer et al., 1984; Kaloo et al., 1993). Hybrid cultivars increased sweet corn yield (Meghji, 1984). Sweet corn as soon as possible cultivation, it will be better performance (Martin and Lindquist, 2007). Breeding and preparation of different sweet corn cultivars, sweet corn performance and the quality of the sweet corn improved (Olaoye et al., 2009 and Alan et al., 2007).

Sweet corn (Zea mays L.), considered a vegetable, is a special type of corn with particular characteristics, such as sweet taste, thin pericarp and endosperm with delicate texture, and a high nutritional value (Kwiatkowski and Clemente 2007). The difference between sweet and common corn is that in the genome of the former, at least one of the eight genes that influence carbohydrate biosynthesis in the endosperm is mutant, preventing the conversion of carbohydrate to starch (Tracy et al. 2006, Qi et al. 2009). Among various types of corn, sweet corn has the greatest potential for use as human food. Sweet corn is originated through mutation and it is characterized by having at least one of the eight mutant genes. The main genes are: Shrunken-2 (sh2) on chromosome 3, Brittle (bt) and Amylose Extender (ae) on chromosome 5, Sugary Enhancer (If), Sugary (su) and “Brittle-2” (BT2) on chromosome 4; “Dull” (du) on chromosome 10, and Waxy (wx) on chromosome 9 (Tracy et al. 2006). In Iran sweet corn was used as forage for animal and feeding for human.

3. PH

A soil pH between 5.8 and 6.2 is adequate for sweet corn production. Sweet corn is sensitive to soil pH, with a substantial yield reduction possible when soil pH is below 5.8. Yield can be 1 to 4 t/a less at soil pH 5.5 than at soil pH 5.8. If the soil pH is below 5.8, added nutrients will not be used efficiently. A soil pH of 6.6 or 6.8 is not detrimental to sweet corn production.

4. Magnesium

Magnesium-deficient sweet corn is uncommon. To ensure sufficient Mg for sweet corn production, add Mg if soil test Mg is below 120 ppm or 1 meq/100 g soil. Magnesium can be supplied from dolomitic lime or fertilizers such as Sul-Po-Mag and K-Mag. These fertilizer materials also supply sulfur.

5. Nitrogen

On a farm with similar rotations, soil, and management, sweet corn yield increased predictably in relation to N application rate. Crop rotations vary in sweet corn production systems, making prediction of N need difficult without a measurement of N supplied from the soil. The pre-sidedress soil nitrate test (PSNT) measures soil N supply, allowing growers to estimate the N application rate needed. PSNT samples are collected during the growing season, before corn begins rapid growth and nutrient accumulation.

Time of application is based on crop uptake. Corn requires little N during the first month to 6 weeks of growth, before it develops five or six leaves. However, N deficiency at early development stages sacrifices yield that cannot be recovered with additional N later.

After development of six leaves, both growth and N use rapidly increase. Adequate N supply is extremely important between the 10-leaf stage and the time silk appears. A shortage of N during rapid growth and N uptake cannot be overcome by adding fertilizer N late in the growing season. An adequately fertilized sweet corn crop will not produce additional yield if fertilized with N after the appearance of silk. Late-season N fertilization increases the risk of N loss before the next cropping season. To ensure adequate N during the period of rapid growth, apply N, if needed, shortly after the corn has five or six leaves. Use plant development (not the calendar) to determine when to apply N.

6. Phosphorus

Determination of P sufficiency is difficult, since the ability of sweet corn to obtain P from the soil is influenced by soil temperature, biological activity, and root diseases.

Ensuring an adequate P supply for sweet corn production is complicated by the insolubility and immobility of biologically available P forms. In contrast to N, P movement is slight. In a growing season, P may move only a distance similar to the thickness of your thumbnail.

Phosphorus deficiency in young corn plants sometimes decreases yield. It is also linked to delayed maturity. Sweet corn is harvested when kernel moisture is 70 to 75 percent, a relatively immature stage of
development when kernels contain only a small portion of dry matter. Uniform maturity is required so that kernel removal or "cut-off" can be maximized. Phosphorus application is associated with shortening the time needed for sweet corn to reach harvest conditions and remain at an acceptable stage of maturity. The yield increase from P application was less for the second harvest than for the first harvest. In addition, increased yield from P addition decreased as soil pH increased.

Young corn plants sometimes exhibit a purple color, which is associated with P deficiency. Silage corn research in British Columbia showed that young corn plants can exhibit a purple color and P deficiency even when the Bray soil test for P is above 50 ppm, a level considered adequate for corn production.

7. Potassium

A sweet corn crop will accumulate as much, and usually more, K than N. Potassium in crop residue is readily available to the next crop. Potassium supplied as KCl (0-0-60) is a very soluble fertilizer salt. Corn, especially at germination, is sensitive to salt damage from fertilizer. To minimize fertilizer salt concentration near the seed, band no more than 50 lb K2O/a when the band is at least 2 inches from the seed. The total of N and K2O banded 2 inches from the seed should not exceed 90 lb/a. When fertilizer is banded within 1 inch of corn seed, the total of N + K2O in the band should not exceed 40 lb/a. If additional K is needed, broadcast and incorporate it before planting.

8. Zn

Routine soil testing for Zn is recommended to identify Zn deficiencies. When the Zn soil test is less than 0.8 ppm, a yield increase from Zn application is expected on all soils.

9. Sweet corn growth

Sweet corn growth and nutrient accumulation can be divided into three segments, each lasting approximately 1 month: (1) planting to the five-leaf stage, (2) the five-leaf stage to silk emergence, and (3) from silk emergence to harvest. For the first month, sweet corn grows slowly, and root development is limited. Fortunately, only small quantities of nutrients are used during this period. Leaf number and height begin to increase rapidly after the appearance of six leaves (growth stage V6). After 10 leaves are produced, sweet corn growth accelerates, with new leaves appearing every 2 or 3 days until silk emergence, or when the sweet corn is about waist high. Although this period of growth and development is short (approximately 30 days), new varieties such as Basin accumulate most of their N during this time. Although this period of growth and development is short (approximately 30 days), new varieties such as Basin accumulate most of their N during this time. Adequate N supply is extremely important between the 10-leaf stage and the time silk appears. A shortage of N during rapid growth and N uptake cannot be overcome by adding fertilizer N late in the growing season. An adequately fertilized sweet corn crop will not produce additional yield if fertilized with N after the appearance of silk. Late-season N fertilization increases the risk of N loss before the next cropping season.

10. Yield

I also researched about sweet corn cultivars in Iran. In order to compare of kernel yield of eight sweet corn hybrids in 2007-2009 and nine sweet corn hybrids in 2005-2008 with conventional sweet corn (SC403) an experiment was conducted in randomized complete block design at the Agricultural and Natural Resources Research Center of Mazandran, Qarakheil, Qaemshahr, Iran (31°28’ N, 52°35’ E). Nine sweet corn hybrids SC417, SC414, SC406, TVC401, TVC402, SC413, SC420, SC410 and SC409 were planted in spring (May) and compared with check (SC403). Eight cultivars named CHASE, CHALLENGER, BASIN, HARVEST GOLD, TEMPTATION, OBSESSION, EX08716636 and POWER HOUSE were planted after rice harvesting (August). Each hybrid was planted in four rows. Each row included 30 plants at 20 cm distance from each other. Harvesting was done in two middle rows. After harvesting, kernel and forage yield for each hybrid determined. Analysis of variance and mean comparison were done. Data were analyzed using the by MSTAT-C procedure to develop the ANOVA for a randomized complete block design. The DMRT procedure was used to make tests of treatment effects by MSTAT-C, all differences reported are significant at P < 0.05 unless otherwise stated.

RESULTS AND DISCUSSION
In Iran sweet corn is important crop in order to human feed for its kernel. Sweet corn is also important in order to forage for animal (especially cow). Sweet corn can be planted in spring and also in summer after wheat or rice harvesting in Mazandaran, Iran. Fresh, high-quality sweet corn is one of the most popular vegetables grown in home gardens and purchased by consumers at roadside stands and farmers’ markets. Sweet corn varieties differ significantly in time to maturity and in sweetness; yellow, white, bi-color, standard, and extra-sweet varieties are available. The best density of sweet corn in Mazandaran is 65000 plant/ha to obtain best kernel yield. A continuous harvest can be planned by planting early-, mid-, and late-season varieties, or by making successive plantings of the same variety every 2 weeks or when the last planting has 3 to 4 leaves (corn sown in early spring will take longer because of cool temperatures).

In 2005-2008 three way cross (TVC) 401 had highest kernel yield with 6.04 t/ha. SC409 with 5.92 t/ha, SC417 with 5.87 t/ha had higher kernel yield than SC403 (Check) with 5.64 t/ha but had not significant difference with SC403. Three way cross (TVC) 402, SC413, SC420, SC410, SC414, SC406 had 5.49 t/ha, 5.47 t/ha, 5.37 t/ha, 5.27 t/ha, 5.06 t/ha and 5.03 t/ha kernel yield respectively. In 2007-2009 BASIN and POWER HOUSE had 7.66 and 7.31 t/ha kernel yield respectively. These hybrids had higher yield than the check (SC403) with 6.11 t/ha and there was significant difference at 5% level between check and these hybrids according to Duncan's Multiple Range Test. EX08716636 Had higher kernel yield than the check (SC403) but this hybrid had not significant difference at 5% level. Hybrids CHALLENGER with 5.34 t/ha, HARVEST GOLD with 5.16 t/ha, OBSESSION with 5.01 t/ha, CHASE with 4.26 t/ha and TEMPTATION with 3.8 t/ha had lower kernel yields than check.

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