

Comparative Study on Early-Maturing High-Quality Sweet Corn Varieties Introduced from Abroad for Autumn Cultivation in the Pearl River Delta Region

Yutong Wu*

Guangdong Experimental High School, Guangzhou, China

*Corresponding author: 13612200019@163.com

Abstract. This study conducts a comparative analysis of six high-quality, early-maturing sweet corn varieties introduced from international sources, with a focus on their suitability for autumn cultivation in the Pearl River Delta region. The research evaluates these varieties against a range of agronomic traits, including growth period, plant height, ear height, yield, quality characteristics, and disease resistance, using the local variety 'Zhu Yu 2' as a control. The results indicate that the introduced varieties generally exhibit earlier maturation and shorter plant heights, with 'Golden 15' and 'Early Honeysweet' standing out as the most promising candidates for local cultivation due to their superior quality attributes. Despite producing lower yields compared to 'Zhu Yu 2', these varieties demonstrate enhanced sweetness, thinner pericarps, and improved taste, which are highly valued in the sweet corn market. Additionally, they show robust disease resistance, particularly against leaf blight and northern corn leaf spot, which is beneficial for sustainable farming practices. This paper provides valuable insights into the adaptability of internationally bred sweet corn varieties to the subtropical climate of the Pearl River Delta and discusses the implications for local agricultural practices. The findings highlight the potential for these varieties to extend the growing season and improve profitability for farmers, while also emphasizing the need for ongoing breeding programs to optimize yield without compromising quality. The study offers a foundation for future research aimed at developing hybrid varieties that combine the best traits of international and local cultivars, tailored to the unique conditions of the region.

Keywords: Sweet corn, Early maturation, Quality traits, Disease resistance, Pearl River Delta, Agronomic evaluation, Sustainable agriculture.

1. Introduction

Sweet corn, known for its high nutritional value and versatility in culinary applications, has seen a significant evolution in breeding and cultivation practices globally [1-3]. Originating from central America, sweet corn has spread across various continents, adapting to diverse climatic conditions and consumer preferences [4]. In recent years, the global sweet corn market has witnessed a surge in demand for varieties that combine early maturation, high yield, and superior quality traits such as sweetness and texture [5]. Countries like the United States have been at the forefront, developing over 500 varieties with traits that cater to both fresh consumption and processing needs [6]. These varieties are characterized by their thin pericarps, high sweetness levels, and uniform kernel arrangement, making them highly competitive on the international stage.

Despite the advancements in sweet corn breeding, the Pearl River Delta Region in China faces unique agricultural challenges due to its subtropical climate, which includes high humidity and temperatures that can affect the growth and quality of traditional sweet corn varieties [7]. The region's farming community has expressed a need for varieties that not only mature early to avoid the peak rainy season but also align with the local taste preferences and processing requirements [8].

This study addresses a significant gap in the local adaptation of internationally bred sweet corn varieties to the Pearl River Delta's specific agronomic conditions [9]. While numerous varieties exhibit desirable traits under temperate climates, their performance in subtropical conditions remains less explored. This gap is critical as the introduction of suitable varieties could lead to an extension of the growing season, potentially increasing the agricultural output and profitability for local farmers. The research focuses on evaluating the adaptability, yield, and quality of six newly introduced sweet

corn varieties under the regional climatic conditions of the Pearl River Delta, aiming to identify those that meet the early maturity and high-quality criteria necessary for successful cultivation in this area.

This paper is structured to systematically present the findings and insights from the comparative trial of sweet corn varieties. Following this introduction, the paper is organized into several key sections: Materials and Methods details the experimental design, including the selection of varieties, planting conditions, and methodologies employed for the evaluation of agronomic traits. Results presents a comprehensive analysis of the growth periods, plant heights, ear positions, yields, and quality traits of the tested varieties, supported by statistical data and visual aids such as tables and graphs. In the Discussion section, we interpret the results, emphasizing the adaptability of the varieties to the Pearl River Delta Region, and discuss the implications for local agricultural practices. Finally, the Conclusion summarizes the key findings and suggests directions for future research, providing actionable insights for both researchers and practitioners in the field of agricultural science.

2. Materials and Methods

2.1. Experimental Materials

In 2023, six high-quality sweet corn varieties were introduced for evaluation: 'Golden 15', 'Honeysweet', 'Early Honeysweet', 'Extra Honeysweet', 'SHZR-010', and 'SHZR-032'. The control variety used was 'Zhu Yu 2', developed by the Zhuhai Agricultural Science Research Center. These varieties were selected based on their potential adaptability to the climatic conditions of the Pearl River Delta Region and their superior agronomic traits reported in preliminary studies.

2.2. Experimental Design and Planting

2.2.1 Location

The trial was conducted at the Zhuhai Modern Agriculture Development Center, which features medium fertility soil, convenient irrigation and drainage systems, and is structured for ridge planting to facilitate experimental manipulation and data collection.

2.2.2 Layout

The experimental design was a randomized complete block design with four replicates per variety. Each plot consisted of four rows of plants with a row spacing of 0.65 meters and a plant spacing of 0.3 meters, resulting in a planting density of 3500 plants per 667 square meters. The middle two rows of each plot were designated for data collection to avoid edge effects.

2.3. Cultivation Practices

Prior to planting, the field was plowed and harrowed. Each mu (a traditional unit of area, approximately 667 square meters) received 100 kg of lime to adjust soil pH. Ridges were approximately 40 cm in height, 120 cm in length, and 80 cm in width, with a central fertilizer trench for easy application of nutrients. Fertilization involved the use of well-rotted chicken manure. Seedlings were transplanted using a transplanting method once they reached the three-leaf stage, and irrigation was immediately applied to ensure good establishment.

2.4. Comprehensive Survey and Evaluation of Agronomic and Quality Traits in Sweet Corn

2.4.1 Overview of Trait Assessments

This section provides a systematic examination of various traits of sweet corn cultivars, including plant and ear morphology, development timing, and quality characteristics. Detailed measurements encompass plant height, shape, color, growing period, ear position, ear length, ear diameter, row number, husk weight, sweetness, and husk thickness. Following data collection, a thorough statistical analysis of the results is conducted to assess variability and significance.

2.4.2 Growth Period Assessment

The growth period is defined as the number of days from sowing to harvest. This fundamental agronomic metric is crucial for understanding cultivar performance under specific climatic and soil conditions.

2.4.3 Measurement of Agronomic Traits and Stress Resistance

For each cultivar under study, ten randomly selected plants are evaluated to measure height and ear characteristics. Measurements are averaged to provide reliable data points. Additionally, assessments conducted ten days post-pollination focus on plant form, uniformity, and resilience to adverse conditions [10]. The bare tip length is specifically measured to determine stress impact, using the average length of ten ears.

2.4.4 Yield Trait Analysis

Quantitative traits such as husk weight, ear length, ear diameter, and row number are measured using precise tools like electronic scales and calipers. Data from ten representative ears are averaged to estimate the yield traits accurately. Selection of cultivars for commercial potential is based on these traits, with emphasis on those demonstrating superior performance.

2.4.5 Quality Trait Evaluation

To ensure uniform quality across thirteen cultivars, controlled pollination is performed by bagging. Post-harvest, the sweet corn is evaluated for taste, sweetness, and husk thickness. This assessment involves a panel of four experts who conduct taste tests on cooked samples. The evaluation focuses on the median of the quality scores to finalize the cultivar ratings [11].

2.5. Replicability

This detailed description of the materials, experimental design, cultivation practices, and statistical methods ensures that other researchers can replicate the study under similar conditions. The precise details provided about the environmental conditions, soil preparation, and plant management practices are crucial for reproducibility and will aid in the validation and comparison of results across different studies.

3. Results

3.1. Growth Period

As shown in Table 1, the growth period of Golden 15 was 63 days, which was 12 days earlier than the control variety, belonging to the ultra-early maturing variety. The growth periods of Honeysweet, Early Honeysweet, and Extra Honeysweet were 67, 65, and 66 days respectively, 8-10 days earlier than the control, all belonging to early maturing varieties. SHZR-010 had a growth period of 70 days, 5 days earlier than the control, belonging to the mid-maturing variety. SHZR-032's growth period was 64 days, 11 days earlier than the control, also an ultra-early maturing variety.

Table 1. Comparison of Developmental Stages and Growing Periods for Different Sweet Corn Varieties.

Varieties	Sowing Date	Silking Date	Pollen Shedding Date	Harvest Date	Growing Period (days)
Gold 15	08-30	10-15	10-12	11-01	63
Honeysweet	08-30	10-17	10-14	11-05	67
Early Honeysweet	08-30	10-14	10-12	11-03	65
Extra Honeysweet	08-30	10-13	10-15	11-04	66
SHZR-010	08-30	10-20	10-19	11-08	70
SHZR-032	08-30	10-14	10-11	11-02	64
Zhu Yu 2 (CK)	08-30	10-22	10-23	11-13	75

In summary, most of the tested varieties had earlier maturity than the control, with early-maturing varieties predominating. Golden 15 had the shortest growth period at 63 days.

3.2. Agronomic Traits and Stress Resistance

Table 2 shows that Golden 15 had a plant height of 184cm and ear height of 55cm, both lower than the control variety, with no barren ear tips. Honeysweet, Early Honeysweet and SHZR-010 had plant heights of 166cm and ear heights of 40-47cm, also lower than the control's 210cm and 75cm respectively, and no barren tips. Extra Honeysweet was 180cm tall with 40cm ear height and 1cm barren tip length, still outperforming the control. SHZR-032 was the shortest at 160cm with 46cm ear height but no barren tips.

Due to the test field being near the foot of a mountain with strong winds, all varieties exhibited excellent lodging resistance. In terms of disease resistance (Table 2), SHZR-010 showed resistance to leaf blight and northern corn leaf spot, while the other varieties were highly resistant. All test varieties displayed high resistance to stalk rot.

Table 2. Comparative Analysis of Agronomic Traits for Different Sweet Corn Varieties.

Varieties	Plant Height (cm)	Ear Height (cm)	Plant Morphology	Uniformity	Barren Ear Tip Length (cm)	Lodging Resistance	Disease Resistance
Gold 15	184	55	Spreading	Good	0	Strong	Highly Resistant
Honeysweet	166	47	Spreading	Good	0	Strong	Highly Resistant
Early Honeysweet	166	45	Spreading	Good	0	Strong	Highly Resistant
Extra Honeysweet	175	40	Spreading	Good	0	Strong	Highly Resistant
SHZR-010	180	42	Spreading	Good	1	Strong	Moderately Resistant
SHZR-032	160	46	Semi-compact	Good	0	Strong	Highly Resistant
Zhu Yu 2 (CK)	210	75	Semi-compact	Fairly Good	1.5	Strong	Highly Resistant

In summary, Golden 15 was the tallest among the 6 test varieties but still shorter than the control Zhuyu 2 at 210cm. Except for the semi-compact SHZR-032, the other 5 varieties had flat plant types. All varieties showed good uniformity, superior to the control. The test varieties also had less barren ear tip issues compared to the control. See Table 2 for details.

3.3. Yield Traits

Table 3 reveals that Golden 15 had an ear length of 15.5cm, ear diameter of 4.6cm, 14-16 kernel rows, 231.3g fresh ear weight with husk, 210g fresh ear weight, and 25.62kg plot yield, all lower than the control variety. Honeysweet, Early Honeysweet and Extra Honeysweet had ear lengths of 17.2-17.5cm, diameters of 4.3-4.7cm, 12-16 kernel rows, 248.9-254.8g fresh ear weights with husk, 207-210.5g fresh ear weights, and 25.06-26.98kg plot yields, also lower than the control. SHZR-010 and SHZR-032 showed ear lengths of 16.3-18.8cm, diameters of 4.5-4.6cm, 12-16 kernel rows, 185.8-220.8g fresh ear weights with husk, 169.5-185.3g fresh ear weights, and 19.01-21.57kg plot yields, again not reaching the control's level.

Table 3. Physical Characteristics and Yield of Different Sweet Corn Varieties.

Varieties	Ear Length (cm)	Ear Diameter (cm)	Kernel Number per Ear	Fresh Weight per Ear with Husks (g)	Fresh Weight per Ear (g)	Yield (kg)
Gold 15	15.5	4.6	14–16	231.3	210	25.62
Honeysweet	17.3	4.3	12–14	248.9	207	26.13
Early Honeysweet	17.2	4.7	14–16	248.9	210.5	26.98
Extra Honeysweet	17.5	4.4	12–14	254.8	207	25.06
SHZR-010	18.8	4.5	12–14	220.8	185.3	21.57
SHZR-032	16.3	4.6	14–16	185.8	169.5	19.01
Zhu Yu 2 (CK)	19.8	4.9	10–12	288	230	29.89

In summary, the 6 varieties did not differ much in kernel row number and ear diameter. SHZR-010 had the longest ears but still shorter than Zhuyu 2's 19.8cm. The main difference was in fresh ear weight with husk, with Early Honeysweet, Extra Honeysweet and Honeysweet all reaching around 250g. Extra Honeysweet had the most outstanding single ear yield but was still lower than Zhuyu 2's 288g. Early Honeysweet achieved the highest plot yield among the 6 test varieties, though not exceeding the control.

3.4. Quality Traits

In the tasting evaluation (Table 4), Golden 15 had a sweetness level of A, on par with the control. Its pericarp thickness and taste were rated A+, better than the control. Honeysweet had a slightly lower A- sweetness than the control, but its A-level pericarp thickness and taste still surpassed the control. Early Honeysweet excelled with A+ sweetness, A pericarp thickness and A+ taste, all superior to the control. Extra Honeysweet had A- sweetness, slightly inferior to the control, but its A+ pericarp thinness and A taste outperformed the control. SHZR-010 was rated B+ in sweetness, worse than the control, but its A- pericarp and A- taste were marginally better. SHZR-032 matched the control's A sweetness and exceeded it with A- ratings in pericarp and taste.

Table 4. Evaluation of Taste and Quality Attributes for Different Sweet Corn Varieties.

Varieties	Degree of Sweet	Pericarp thickness	Tastiness	Quality evaluation
Gold 15	A	A+	A+	A+
Honeysweet	A-	A	A	A
Early Honeysweet	A+	A	A+	A+
Extra Honeysweet	A-	A+	A	A
SHZR-010	B+	A	B+	A-
SHZR-032	A	A-	A-	A-
Zhu Yu 2 (CK)	A	B	B	B

Note: A+ indicates excellent performance

Overall, all 6 test varieties had thinner pericarps and better taste than the control. Early Honeysweet had the highest sweetness, while Extra Honeysweet and Golden 15 had the most tender pericarps. Early Honeysweet and Golden 15 topped the taste ranking. The best overall performers were Early Honeysweet and Golden 15.

3.5. Variety Comprehensive Evaluation

Golden 15: 63-day growth period, 184cm plant height, flat plant type, good uniformity, no barren tips, strong stress resistance. Golden kernels, 14-16 rows, 15.5cm ear length, 4.6cm ear diameter, 231.3g fresh ear weight with husk. Overall rating A+.

Honeysweet: 67-day growth period, 166cm plant height, flat plant type, good uniformity, no barren tips, strong stress resistance. Golden kernels, 12-14 rows, 17.3cm ear length, 4.3cm ear diameter, 248.9g fresh ear weight with husk. Overall rating A.

Early Honeysweet: 65-day growth period, 166cm plant height, flat plant type, good uniformity, no barren tips, strong stress resistance. Golden kernels, 14-16 rows, 17.2cm ear length, 4.7cm ear diameter, 248.9g fresh ear weight with husk. Overall rating A+.

Extra Honeysweet: 66-day growth period, 175cm plant height, flat plant type, good uniformity, no barren tips, strong stress resistance. Golden kernels, 12-14 rows, 17.5cm ear length, 4.4cm ear diameter, 254.8g fresh ear weight with husk. Overall rating A.

SHZR-010: 70-day growth period, 180cm plant height, flat plant type, good uniformity, 1cm barren tip length, strong lodging resistance, moderate resistance to leaf blight. Golden kernels, 12-14 rows, 18.8cm ear length, 4.5cm ear diameter, 220.8g fresh ear weight with husk. Overall rating A-.

SHZR-032: 64-day growth period, 160cm plant height, semi-compact plant type, good uniformity, no barren tips, strong stress resistance. Golden kernels, 14-16 rows, 16.3cm ear length, 4.6cm ear diameter, 185.8g fresh ear weight with husk. Overall rating A-.

Zhuyu 2 (Control): 75-day growth period, 210cm plant height, semi-compact plant type, good uniformity, 1cm barren tip length, strong stress resistance. Yellow kernels, 12-14 rows, 19.8cm ear length, 4.9cm ear diameter, 288g fresh ear weight with husk. Overall rating B.

The results described above have also presented in Table 5.

Table 5. Overview of Agronomic Traits and Ratings for Seven Sweet Corn Varieties.

Variety	Gro wth Peri od (day s)	Pla nt Hei ght (cm)	Plan t Type	Unifor mity	Bar ren Tips	Stress/Lo dging Resistanc e	Ker nels Colo r	Ro ws per Ea r	Ear Len gth (cm)	Ear Diam eter (cm)	Fres h Ear Wei ght with Hus k (g)	Ove rall Rati ng
Golden 15	63	184	Flat	Good	Non e	Strong stress resistance	Gold en	14-16	15.5	4.6	231.3	A+
Honeys weet	67	166	Flat	Good	Non e	Strong stress resistance	Gold en	12-14	17.3	4.3	248.9	A
Early Honeys weet	65	166	Flat	Good	Non e	Strong stress resistance	Gold en	14-16	17.2	4.7	248.9	A+
Extra Honeys weet	66	175	Flat	Good	Non e	Strong stress resistance	Gold en	12-14	17.5	4.4	254.8	A
SHZR-010	70	180	Flat	Good	1cm	Strong lodging, moderate leaf blight resistance	Gold en	12-14	18.8	4.5	220.8	A-
SHZR-032	64	160	Semi - compact	Good	Non e	Strong stress resistance	Gold en	14-16	16.3	4.6	185.8	A-
Zhuyu 2 (Contr ol)	75	210	Semi - compact	Good	1cm	Strong stress resistance	Yell ow	12-14	19.8	4.9	288.0	B

4. Discussion

4.1. Early Maturity and Planting Strategy

The study systematically compared six high-quality sweet corn varieties introduced from abroad, highlighting significant differences in their growth cycles. The early maturity of foreign varieties such as 'Gold 15', 'Early Honeysweet', and 'Extra Honeysweet' presents a strategic advantage for early season planting. This allows farmers to market their produce ahead of standard local varieties, potentially capturing premium prices. Early maturing varieties can also potentially evade late-season pest pressures, reducing crop loss and the need for chemical pesticides.

4.2. Plant Height and Crop Quality

Despite their shorter stature, which might be seen as a drawback in terms of total biomass, the imported varieties exhibited superior quality traits, such as higher sweetness levels and better kernel texture. These features are highly desirable in the sweet corn market. Additionally, the shorter plant height reduces susceptibility to wind damage, a significant benefit in typhoon-prone regions.

4.3. Yield Considerations

One notable challenge observed was the generally lower yield of these introduced varieties compared to the local control 'Zhu Yu 2'. This poses a potential issue for commercial growers where yield per hectare is critical for profitability. This finding underscores the need for continued breeding efforts to enhance yield while maintaining desirable quality traits.

4.4. Disease Resistance and Sustainability

The disease resistance noted in varieties like 'Honeysweet' and 'SHZR-032' is particularly promising. Effective disease resistance enhances sustainability by reducing the reliance on chemical pesticides and supports the production of healthier crops. This aspect is crucial for maintaining productivity and environmental health in agricultural systems.

4.5. Adaptability to Local Conditions

Finally, while all introduced varieties showed good performance under the controlled conditions of the Zhuhai Modern Agriculture Development Center, the variability in their growth periods and disease resistance profiles suggests that further selection may be necessary for optimal performance across different locales in the Pearl River Delta. Varieties suited to specific environmental conditions can offer more reliable performance and better adapt to local agricultural challenges.

4.6. Concluding Remarks

In conclusion, the foreign sweet corn varieties introduced possess promising qualities, particularly in terms of crop quality and disease resistance. However, their lower yield and specific adaptational needs highlight the importance of targeted breeding programs. Future efforts should aim to develop hybrid varieties that combine the high-quality characteristics of foreign varieties with the yield capabilities of local strains, tailored specifically to the conditions of the Pearl River Delta.

5. Conclusion

The comprehensive study presented in this paper evaluates the adaptability and performance of six high-quality, early-maturing sweet corn varieties introduced from abroad, specifically tailored for the autumn cultivation in the Pearl River Delta region. This research is pivotal as it addresses the pressing need for crop varieties that can adapt to the subtropical climate of the region, characterized by high humidity and temperatures, which are less than ideal for traditional sweet corn cultivation. Our findings reveal that while these introduced varieties generally mature earlier and are shorter in stature compared to the local control variety, Zhu Yu 2, they produce lower yields. However, they excel in several critical quality parameters, including sweetness, pericarp thickness, and overall taste, which are essential for market acceptance and consumer satisfaction. Notably, varieties such as 'Golden 15' and 'Early Honeysweet' have shown promising overall traits, combining early maturity with superior quality characteristics, making them suitable candidates for local cultivation. Despite the lower yield, the enhanced quality traits of these varieties could potentially fetch premium prices in the market, compensating for the lesser volume produced per hectare. Moreover, the early maturity of these varieties allows for an extended growing season, providing a strategic advantage by potentially evading late-season pest pressures and the peak rainy season, thus reducing crop loss and diminishing the reliance on chemical pesticides. The study also highlights the robust disease resistance observed in these varieties, particularly against common pathogens such as leaf blight and northern corn leaf

spot, which is crucial for sustainable agricultural practices. This resistance not only reduces the dependency on chemical interventions but also supports healthier crop production and environmental conservation.

In conclusion, while the introduced sweet corn varieties show a reduction in yield, their superior quality attributes and disease resistance present a valuable trade-off. These findings underscore the necessity for ongoing breeding programs aimed at enhancing yield without compromising the quality gains observed. Future research should focus on hybrid varieties that amalgamate the high-quality traits of these international varieties with the yield prowess of local cultivars, tailored specifically to thrive in the unique conditions of the Pearl River Delta. This approach will not only improve the profitability and sustainability of local farming practices but also contribute to the broader goal of food security and agricultural diversity in the region.

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