Journal of Tropical Crop Science Vol. 3 No. 1, February 2016
www.j-tropical-crops.com

# Evaluation of Yield Components of New Sweet Corn Hybrids in Bogor, Indonesia

**Devi Kurnia Aprilianti, Muhamad Syukur*, Willy Bayuardi Suwarno**

Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University
Jl. Meranti, Kampus IPB Dramaga 16680, Bogor, Indonesia

*Corresponding author; email: muhsyukur@ipb.ac.id

## Abstract

The demand of sweet corn in Indonesia has been increasing; therefore breeding efforts are aimed for high yielding sweet corn varieties with superior quality. This research was aimed to evaluate the yield of five newly developed sweet corn hybrids compared to the commercial varieties. The research was conducted at the Leuwikopo experimental field of IPB, and Laboratory of Genetics and Plant Breeding, Department of Agronomy and Horticulture, IPB Darmaga campus from September to December 2015. The experiment was arranged in a completely randomized block design with three replications. Five new sweet corn hybrids, " JM8 x JM2", "JM8 x JM7", "JM16 x JM8", "JM17 x JM6" and "JM17 x JM7", and four commercial varieties, "Bonanza", "Master Sweet", "Sugar 75" and "Sweet Boy", were tested. The results showed that the new hybrids vary in plant height, days to anthesis, days to silking, ear height, ear length, sugar content, number of kernel rows, the weight of husked ear, and number of ears per plant, downy mildew infected area, and productivity. F1 of "JM8 x JM2" has longer ears than "Master Sweet" and "Sugar 75", higher sugar content than "Sugar 75", and higher resistance against downy mildew than "Master Sweet" and "Sweet Boy".

Keywords: corn breeding, genotype, hybrid, varieties

## Introduction

Sweet corn (*Zea mays* var. *Saccharata*) is classified as a horticultural crop. The sweet taste of the corn kernel is a result of a recessive mutation that occurs naturally in the genes that control the conversion of sugar to starch in the endosperm of corn kernels (Sujiprihati et al., 2012). Sweet corn yield is generally low compared to regular corn, partially due to the lack of availability of high yielding sweet corn varieties.

The demand of fresh sweet corn for fresh and processed food has been increasing (Syukur and Rifianto, 2013). The limited supply of sweet corn in Indonesia has led to increased import from 1,010,178 tons in 2011, 1,083,586 tons in 2012, 1,097,427 tons in 2013, and 1,125,463 tons in 2014 (BPS, 2015). Therefore, it is necessary to develop superior, high yielding sweet corn varieties through plant breeding. The characters of sweet corn that contribute to quality include softness of the pericarp, the degree of sweetness, flavor, aroma, and physical appearance (Syukur et al., 2015).

One of the important steps to develop high yielding corn varieties is through expanding the use of hybrids and composite varieties with superior seed quality, along with application of advanced farming technology (Deptan, 2005). The most important factor in the development of sweet corn hybrid is the selection of germplasms to provide the basis of the population that will determine the availability of superior parents. Important traits of corn hybrids include high yields, early maturity, and have high resistant to pests and diseases (Iriany et al., 2007).

The final stage of breeding is the yield evaluation of the candidate varieties prior to the release and distribution to the commercial growers (Syukur et al., 2015). The purpose of this study was to evaluate the yield of five newly developed sweet corn hybrids in comparison to the commercial sweet corn varieties.

## Materials and Methods

This research was conducted at the Leuwikopo experimental field of IPB, Dramaga and in the Laboratory of Genetics and Plant Breeding, Department of Agronomy and Horticulture, IPB from September to December 2015. Five sweet corn new hybrids, F1 of " JM8 x JM2", "JM8 x JM7", "JM16 x JM8", "JM17 x JM6" and "JM17 x JM7" and four commercial varieties "Bonanza", "Master Sweet", "Sugar 75" and "Sweet Boy" were tested. This study used a single factor in a randomized complete block design with genotype as a factor. The experiment was replicated three times with a total of 27 experimental units.

Sweet corns were grown in the open field. Manure with a dose of 15 $t.ha^{-1}$ was applied during land preparation and soil tillage. Plant spacing was 75 cm x 25 cm with a plot size of 11.25 $m^2$. Seeds were planted 2-3 cm depth using a drill, each hole was planted with one seed supplemented with ±5 g of Carbofuran 3G. Urea at 150 $kg.ha^{-1}$, SP-36 at 200 $kg.ha^{-1}$, and KCl at 200 $kg.ha^{-1}$ were applied at planting five to seven cm from the planting holes. Plant maintenance includes watering, shading, and weed, pest and disease control. Carbofuran 3G was applied at the growing points at four WAP followed by adding soils to the sides of plant rows and second fertilization with the remaining of the urea (150 $kg.ha^{-1}$). Weed control was done manually at 14, 28 and 42 DAT.

Scoring was performed on ten plant samples randomly selected from each experimental unit. Plant height, stem diameter, leaf size, days to flowering, days to harvest, ear size, sugar content, number of kernel rows, ear weight, number of ears per plant, downy mildew infection area, and productivity were measured. The downy mildew infection area was evaluated at 30-37 DAP by calculating the ratio of the number of infected to non-infected plants. Sweet corn productivity was calculated using the following formula:

$$\text{Yield = the average ear weight (ton) x } \frac{10000\ (m^2)}{\text{The area of the plot } (m^2)}$$

Data were analyzed by the F test using SAS program 9.1.3 to determine the effect of treatments; significant results were further tested using DMRT at the level of α = 5% to determine differences among the genotypes.

## Results and Discussion

Genotype effects were highly significant on days to anthesis, days to silking, ear weight, ear length, number of kernel rows, weight of ear per plant, weight of husked ear, downy mildew infection area, and yield of husked ear. Genotype effects were significant on

Table 1. Analysis of variance of the sweet corn characters

| Sources of variation | Mean of square | | Coefficient of variation (%) |
|---|---|---|---|
| | Replication | Genotype | |
| Plant height (cm) | 430.86ns | 508.64* | 5.16 |
| Stem diameter (mm) | 6.82ns | 18.74ns | 11.81 |
| Leaf length (cm) | 20.32ns | 28.76ns | 4.75 |
| Leaf width (cm) | 1.35ns | 6.08ns | 17.71 |
| Days to anthesis (DAP) | 128.25** | 9.09** | 2.83 |
| Days to silking (DAP) | 120.03** | 10.23** | 2.66 |
| ASI (days) | 0.14ns | 0.23ns | 24.34 |
| Days to harvesting (DAP) | 639.81** | 19.70ns | 3.84 |
| Ear height (cm) | 225.67ns | 728.08** | 7.53 |
| Number of ears per plant | 0.16ns | 0.16* | 14.46 |
| Ear diameter (mm) | 40.52ns | 20.67ns | 7.20 |
| Ear length (cm) | 0.74ns | 4.70** | 4.50 |
| Sugar content (°Brix) | 0.49ns | 2.84* | 7.37 |
| Number of kernel rows | 0.40ns | 5.06** | 4.03 |
| Weight of ears per plant (g) | 6643.72ns | 15397.58** | 12.15 |
| Weight of husked ear (g) | 1380.21ns | 12743.79** | 12.36 |
| Ear weight (g) | 4896.59ns | 4649.11ns | 15.77 |
| Downy mildew infection area (%) [t] | 0.62ns | 46.86** | 27.17 |
| Yield ear without husk ($ton.ha^{-1}$) | 11.65ns | 17.01* | 16.70 |
| Yield husk ear ($ton.ha^{-1}$) | 8.75ns | 43.47** | 12.91 |

Note: ** highly significant effects at 1%; * significant at 5%; $^{ns}$ not significant at 5%; $^{t}$ transformed data = $\sqrt{x+0.5}$

plant height, number of ears per plant, sugar content, and ear yield without husk (Table 1). Genotypes did not affect stem diameter, leaf length, leaf width, anthesis and silking interval (ASI), days to harvesting, ear diameter, and ear weight (Table 1).

Recapitulation of variance demonstrated a wide range of coefficient of variance (CV) amongst variables. CV values indicate the level of accuracy of comparison between treatments, and provide good indexes on the trial results (Gomez and Gomez, 2007). The highest CV value was shown by area infected with downy mildew, and the lowest CV value lowest was shown by days to silking (Table 1).

Scoring of plant height, stalk diameter, leaf length and leaf width were conducted at the end of the vegetative period, or when tassel begin anthesis. Analysis of variance indicated that stem diameter, leaf length, and leaf width of the tested genotypes were similar to the commercial varieties. It can be assumed that the genotypes and varieties have similar size and efficiency of light interception.

The stem diameter of the new hybrids and the commercial varieties were 2.05-2.81 cm; whereas the leaf length was 96.1-104.4 cm and 10.9-14.6 cm, respectively (Table 2). The new hybrids have similar leaf size to the commercial varieties (Table 1). F1 of “JM8 x JM2”, “JM8 x JM7” and “JM16 x JM8” are relatively short, the similar to commercial variety “Sugar 75” (Table 2). Tall is one of the unwanted physical traits in sweet corn as it could increase the risk of lodging (Widowati, 2016).

Days to anthesis and days to silking of F1 of “JM8 x JM2”, “JM16 x JM8”, and “JM17 x JM6” were not significantly different from those of “Sugar 75” (Table 2). This suggests that these new hybrids are relatively early.

The ASI value of the new hybrids and commercial varieties ranged from 2.3-3.0 days. ASI affects pollination process that would determine the success rate of fertilization. The larger the ASI value the smaller ASI synchronization of flowering, which means pollinating become inhibited and resulting in lower output. On the other hand, smaller the ASI values will improve synchronization of flowering and can potentially improve yields (Wahyudi et al. 2006). Further, Lubis (2014) reported that sweet corn genotypes with smaller ASI values adapt better to acidic soils (Lubis, 2014).

Days to harvesting of the new hybrids were not significantly different to those of the commercial varieties. Days to harvest of new hybrids and the commercial varieties were 73.3-80.6 DAP. Sweet corn varieties which were bred for human consumption is usually harvested at 64 to 82 DAP, and this trait is influenced by plant variety and elevation of the growing area. Sweet corn that was harvested too late had hardened hearts and reduced sweetness due the conversion of sugar into starch (Syukur and Rifianto, 2013).

Ear height of “JM8 x JM2” was not significantly different from that of “Sugar 75”, indicating that both have low ear positions (Table 3). Ear height is an important character for sweet corn; lower ear position eased harvesting and posed less burden to the plant. This is consistent with the studies by Yuliandry (2004) that reported a higher risk of lodging in plants with high ear position.

Number of ears of the five new hybrids was not

Table 2. Sweet corn plant height, days to anthesis and days to silking

| Genotype | Plant height (cm) | Days to anthesis (DAP) | Days to silking (DAP) |
|---|---|---|---|
| F1 of “JM8 x JM2” | 238.5c | 52.0ab | 54.3bc |
| F1 of “JM8 x JM7” | 249.9bc | 55.6a | 58.0ab |
| F1 of “JM16 x JM8” | 246.5bc | 51.3ab | 54.6abc |
| F1 of “JM17 x JM6” | 270.4a | 53.3ab | 56.0abc |
| F1 of “JM17 x JM7” | 274.7a | 55.6a | 58.6a |
| “Bonanza” | 263.1ab | 52.3ab | 54.6abc |
| “Master Sweet” | 252.8abc | 54.3ab | 57.0abc |
| “Sugar 75” | 238.0c | 51.0b | 53.0c |
| “Sweet Boy” | 252.5abc | 52.6ab | 55.3abc |

Note: numbers in the same column followed by the same letter were not significantly different at 5% DMRT.

significantly different from “Bonanza”, “Sugar 75” and “Sweet Boy” (Table 3). F1 of “JM16 x JM8” has more ears than “Master Sweet”. Ear length of “Bonanza” was not significantly different to five new hybrids (Table 3), whereas the ear diameter was not significantly different to the commercial varieties, i.e. 42.6-50.1 mm. This suggests that “Bonanza” has the similar ear size to the new hybrids. According to Ridwan and Zubaidah (2003) the differences in the ear length and ear diameter are unique characteristics of corn variety. The length and diameter of the ear can visually provide a description of the size of the ear, which is an important character in assessing the quality of the harvest.

Sugar content is an important quality of sweet corn. Sugar content is affected by growing temperature and storage duration after harvest prior to sugar content measurement. Late harvest time also could result in lower sugar content. The highest sugar content in korn kernels occurred at around 20 days after female flower initiation (Syukur and Rifianto, 2013). High rainfall intensity during the ear begins to fill the kernels could lower sugar content in corn kernels. F1 of “JM17 x JM6” kernels contains high level of sugar, i.e. 14.1 °Brix, even though it was not significantly different with the F1 of “JM8 x JM2 and “JM8 x JM7” (Table 3).

Kernels filling capacity can be predicted by a number of kernel rows on the ear. The number of kernel rows on the ear will determine the sweet corn production. The largest ear diameter does not always guarantee that the ear will have the greatest number of kernel rows. This can be expected because of the size of the seed vary with genotypes or varieties (Siregar, 2014).

Table 3. Sweet corn ear height, number of ear per plant, ear length, and kernel sugar content

| Genotype | EH (cm) | NEP | PT (cm) | SC (°brix) |
|---|---|---|---|---|
| F1 of “JM8 x JM2” | 114.3bc | 1.5ab | 23.1a | 13.3abc |
| F1 of “JM8 x JM7” | 125.6ab | 1.5ab | 21.5abc | 13.6ab |
| F1 of “JM16 x JM8” | 122.5ab | 1.8a | 22.2abc | 12.1bcd |
| F1 of “JM17 x JM6” | 141.2ab | 1.4ab | 21.5abc | 14.1a |
| F1 of “JM17 x JM7” | 145.1a | 1.2ab | 22.9ab | 11.7cd |
| “Bonanza” | 132.4ab | 1.7a | 23.1a | 12.1bcd |
| “Master Sweet” | 119.8abc | 1.0b | 20.2bc | 12.7abcd |
| “Sugar 75” | 95.0c | 1.5ab | 20.0c | 11.1d |
| “Sweet Boy” | 129.3ab | 1.6ab | 20.4abc | 12.8abcd |

Note: EH = ear height, NEP = number of ears per plant, PT = ear length, SC = sugar content; numbers in the same column followed by the same letter were not significantly different at 5% DMRT

Table 4. Number of kernel rows, weight of ear per plant, weight of husked ear, and downy mildew infection area of the new sweet corn hybrids in comparison to the commercial varieties

| Genotype | NKR | WEP (g) | WHE (g) | DM (%) |
|---|---|---|---|---|
| F1 of “JM8 x JM2” | 14.8d | 436.5ab | 375.2ab | 0.6c |
| F1 of “JM8 x JM7” | 15.6bcd | 427.1ab | 357.6ab | 0.6c |
| F1 of “JM16 x JM8” | 14.1d | 450.0ab | 338.0ab | 0.0c |
| F1 of “JM17 x JM6” | 17.2ab | 495.0a | 468.6a | 1.2c |
| F1 of “JM17 x JM7” | 17.2ab | 520.4a | 467.3a | 1.8c |
| “Bonanza” | 17.6a | 559.4a | 458.0a | 0.0c |
| “Master Sweet” | 16.8abc | 311.7b | 302.8b | 12.4b |
| “Sugar 75” | 15.3cd | 502.9a | 435.6ab | 0.0c |
| “Sweet Boy” | 14.7d | 432.8ab | 329.8ab | 23.9a |

Note: NKR = number of kernel rows, WEP = weight of ears per plant, WHE = weight of husked ear, DM = downy mildew infection area; numbers in the same column followed by the same letter were not significantly different according to DMRT at 5%.

“Bonanza” had more kernel rows than the other, but it was not significantly different from number of kernel rows in “JM17 x JM6” and “JM17 x JM7” (Table 4).

The weight of husked ear is a gross weight of sweet corn ears. “Bonanza” has relatively heavy husked ears per plant and husked main ear, but they were not significantly different from those of the five test genotypes. F1 of “JM17 x JM6” and “JM17 x JM7” have higher weight of ears per plant than “Master Sweet” variety (Table 4). The weight of the main ear without husk of the new hybrids was not significantly different to check varieties. These results indicated that the heaviness of the husk greatly affects husk ear weight.

The five new hybrids showed a high resistance to downy mildew, indicated by relatively smaller infection area compared to those of “Master Sweet” and “Sweet Boy” (Table 4).

Yield of ear without husk and husked ear of all genotypes was quite high. “Bonanza” had the highest ear yield without husk (16.51 $t.ha^{-1}$) but it was not significantly different from the test genotypes (Table 5). High yield potential is determined by the interactions of corresponding genes that were inherited from the parents (Iryani et al., 2011), and highly depend on environmental condition. Heavy rainfall during the vegetative growth was unfavorable for sweet corn growth (Sujiprihati et al., 2006 and Haddade, 2013). The five new hybrids in this study demonstrated similar growth character and yield.

Table 5. Ear yield without hust and husked ear yield of the new sweet corn hybrids in comparison to the commercial varieties

| Genotype | Ear yield without husk ($t.ha^{-1}$) | Husked ear yield ($t.ha^{-1}$) |
|---|---|---|
| F1 of “JM8 x JM2” | 12.78abc | 17.80abc |
| F1 of “JM8 x JM7” | 12.39abc | 17.87abc |
| F1 of “JM16 x JM8” | 11.80abc | 16.76abc |
| F1 of “JM17 x JM6” | 14.69ab | 22.36a |
| F1 of “JM17 x JM7” | 13.45abc | 22.29a |
| “Bonanza” | 16.51a | 22.32a |
| “Master Sweet” | 8.45c | 12.35c |
| “Sugar 75” | 13.29abc | 19.75ab |
| “Sweet Boy” | 10.03bc | 16.21b |

Note: numbers in the same column followed by the same letter are not significantly different at not according to DMRT at 5 %

## Conclusion

Evaluation of the new sweet corn hybrids in comparison to the commercial sweet corn varieties showed that the new hybrids vary in plant height, days to anthesis, days to silking, ear height, ear length, sugar content, number of kernel rows, weight of husked ear, and number of ears per plant, downy mildew infection area, and yield. F1 of “JM8 x JM2” has longer ears than those of “Master Sweet” and “Sugar 75”, greater kernel sugar content than “Sugar 75”, and higher resistance against downy mildew than “Master Sweet” and “Sweet Boy”. “JM17 x JM6” kernels have a higher sugar content than “Bonanza” and “Sugar 75”.

## Acknowledgement

The authors thank the Center for Tropical Horticulture Studies, Bogor Agricultural University for funding support to this research.

## References

Badan Meteorologi Klimatologi dan Geofisika (BMKG). (2015). “Data Iklim Tahun 2015”. Stasiun Klimatologi Dramaga. Bogor.

Badan Pusat Statistik. (2015). “Tabel Impor menurut Komoditi”. https://www.bps.go.id/all_newtemplate.php [April 13, 2016].

Departemen Pertanian. (2005). “Rencana Aksi

Ketahanan Pangan". Badan Penelitian dan Pengembangan Pertanian. Jakarta.

Gomez, K.A. and Gomez, A.A. (2007). "Prosedur Statistik untuk Penelitian Pertanian". UI Press. Jakarta.

Haddade, I. (2013). "Evaluasi Daya Hasil Genotype Jagung Hibrida pada Lahan Podsolik Merah Kuning di Sulawesi Tenggara". Seminar Nasional Serealia. Balai Pengkajian Teknologi Pertanian Sulawesi Tenggara.

Iriany, R.N., Yasin, M., Takdir, A. (2007). Asal, sejarah, evolusi, dan taksonomi tanaman jagung p 1-15. *In* "Jagung" (Sumarno, Suyamto, Widjono A., Hermanto, Kasim H., eds). Pusat Penelitian dan Pengembangan Tanaman Pangan, Departemen Pertanian. Jakarta.

Iriany, R.N., Sujiprihati, S., Syukur, M., Koswara, J., and Yunus, M. (2011). Evaluation of combining ability and heterosis of five sweet corn lines (*Zea mays* var. *saccharata*) through diallel crossing. *Jurnal Agronomi Indonesia* **39**,103-111.

Lubis, K. (2014). "Identifikasi dan Pendugaan Parameter Genetik Karakter Morfologi dan Hasil untuk Toleransi Cekaman Aluminium pada Tanaman Jagung (*Zea mays* L.)". Thesis. Program Studi Pemuliaan dan Bioteknologi Tanaman, Institut Pertanian Bogor. Bogor.

Ridwan, Y. and Zubaidah. (2003). Effect of land preparation and vatiety on yield of maize on upland area. *Jurnal Stigma* **11**,128-131.

Siregar, A. (2014). "Daya Hasil dan Kualitas Jagung Manis (*Zea mays* var. *saccharata* Sturt.) Genotype SD-3 dengan Empat Varietas Pembanding di Kabupaten Bogor". Thesis. Institut Pertanian Bogor. Bogor.

Sujiprihati, S., Syukur, M., and R. Yunianti, R. (2006). The analysis of stability of seven sweet corn populations using additive main effect multiplicative interaction (AMMI). *Buletin Agronomi* **34**, 93-97.

Sujiprihati, S., Syukur, M., Makkulawu, A.T., and Iriany, R.N. (2012). Improvement of hybrid varieties of sweet corn for high yield and resistancy toward downy mildew disease. *Jurnal Ilmu Pertanian Indonesia* **17**, 159-165.

Syukur, M. and Rifianto, A. (2013). "Jagung Manis". Penebar Swadaya, Jakarta.

Syukur, M., Sujiprihati, S. and Yunianti, R. (2015). "Teknik Pemuliaan Tanaman". Revised Edition. Penebar Swadaya. Jakarta.

Wahyudi, M.H., Setiamihardja, Baihaki, R., and Ruswandi A. (2006). Combining ability and heterosis evaluation of hybrids generated from five maize genotypes through diallel crossing under drought condition. *Jurnal Zuriat* **17**, 1-9.

Widowati, A., Ainurrasjid, and Sugiharto A.N. (2016). Characterization of some sweet corn (*Zea mays* L. Saccharata) inbred lines. *Jurnal Produksi Tanaman* **4**, 1-7.

Yuliandry, A. (2004). "Uji fenotipik dan karakter agronomi 22 genotype jagung (*Zea mays* L.) quality protein maize (QPM) berbiji kuning di dua lokasi pengujian". Thesis. Institut Pertanian Bogor. Bogor.