

Research article

**Leaf and Dwarf Disease Incidence and Severity
in Sweet Corn Hybrids, Along with Their Implications
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Received: 18 March 2025, Revised: 9 April 2026, Accepted: 9 April 2026, Published: 20 July 2026

Abstract

The production of sweet corn encounters considerable challenges stemming from biotic stressors, especially foliar diseases and viral infections, which diminish productivity even with expanded cultivation areas. This study was performed to evaluate the influence of prevalent leaf and dwarf mosaic virus diseases on the ear yield of 17 sweet corn hybrids. The study was conducted at the coastal area of Bengkulu University's experimental station (15 m asl). The experiment was set up on a randomized complete block design with three replications to allocate 15 experimental hybrids and 2 commercial varieties on the plots, each with a population density of 48 plants. Data were collected for leaf disease incidence, severity, and progress, dwarf disease symptoms, ear length and diameter, ear weight (unhusked and husked), kernel row number, kernel number per row, and ear yield. Leaf spots, eyespot with halos, corn leaf blight, and corn rust were the prominent leaf diseases found on the plant population as measured at three months after planting (MAP), with the level of incidence ranging from 23.29% to 32.17%, and the level of severity ranging from 15.17% to 21.67%. No significant differences were observed among the hybrids for the level of disease incidence and severity, and all hybrids exhibited moderate resistance to the leaf diseases under consideration. However, the evaluation of disease progress using the area under the disease progress curve (AUDPC) formula indicated that Caps3 × Caps17B was the most susceptible hybrid, while Caps2 × Caps22 was the most resistant hybrid. Dwarf disease, as indicated by variegata symptoms, was not found in all hybrids, notably in Caps3 × Caps17A, Caps15 × Caps22, Caps17A × Caps22, and Caps17B × Caps23. The remaining hybrids showed the symptoms, with incidence varying between 1.0% and 3.0% of the plant populations. The observations made on the characteristics of crop productivity showed that significant variations among the hybrids existed for ear yield and its contributing traits.

Keywords: disease; dwarfing; hybrid; incidence; severity; sweet corn

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<https://doi.org/10.55003/cast.2026.266772>

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1. Introduction

Sweet corn (*Zea mays* L. var. *saccharata*) has emerged as a valuable crop not only for its nutritional benefits but also for its economic value. The kernels can serve as a good source of dietary fiber, protein, vitamins, antioxidants, and minerals, which support digestive and eye health and may reduce the risk of chronic diseases (Swapna et al., 2020; Baranowska, 2023). Sweet corn is economically important due to its versatility for food and feed, income contribution, and job creation in supply chains. The short growing period of the crop (typically 60-90 days) also contributes significantly to its economic importance by enabling multiple cropping seasons in a single year, serving as a profitable cash and catch crop, and providing a quick return on investment for farmers (dos Reis et al., 2022).

Growing sweet corn to achieve high yield with desirable ear characteristics requires specific genotypes for particular environmental conditions, both abiotic and biotic. Most areas of Indonesia are characterized by tropical climate, which is generally hot, humid, and has high rainfall throughout the year, with temperatures hovering around 26-28°C (Fahrurrozi et al., 2019; Muktamar et al., 2021; Fahrurrozi et al., 2024). Consequently, genotypes performing well and productively under such conditions are preferred. However, such climatic conditions to a greater extent provide favorable conditions for the development of various types of plant diseases (Abebe et al., 2008; Muis et al., 2022; Mirsam et al., 2023; Cao et al., 2024).

It is estimated that there is a minimum of ten diseases that affect sweet corn plants in Indonesia, during both vegetative and generative stages (Setyawan et al., 2016; Habibullah et al., 2020; Mirsam et al., 2023, 2025). Common diseases impacting sweet corn during the vegetative stage include northern corn leaf blight caused by *Helminthosporium turcicum* (Mirsam et al., 2023; Saquee et al., 2023), southern rust by *Puccinia polysora* (He et al., 2022; Firmansyah & Nafi'iyah, 2024; Riyadi et al., 2024), and downy mildew by *Peronosclerospora maydis* (Habibullah et al., 2020; Muis et al., 2022; Riyadi et al., 2024). In contrast, prevalent diseases during the generative stage include ear rot by *Gibberella zeae*, diplodia ear rot by *Stenocarpella maydis*, anthracnose stalk rot by *Colletotrichum graminicola*, ear rot, stalk rot, and crown rot by *Fusarium* spp. and bacterial stalk rot by *Dickeya zeae* (Pataky et al., 1998; Kainyu, 2014; Setyawan et al., 2016; Mengist & Moges, 2019; Meng et al., 2024).

Certain diseases require more attention, particularly those that are commonly found on leaves, such as northern corn leaf blight and common rust. This is due to their potential to greatly diminish both yield and quality by harming the leaves, which in turn reduces the plant's capacity for photosynthesis and may result in premature death of the plant. Additionally, these diseases can create complications with the ears, impacting marketability, and may make the stalks more susceptible to lodging. Another disease that needs attention is dwarfism, which is caused by maize dwarf mosaic virus (MDMV). The disease can cause significant yield loss through reduced ear size, poor kernel development, and stunted growth (Kannan et al., 2018), which subsequently lowers both the quantity and quality of the ear yield and may increase the severity of other fungal diseases (Meyer & Pataky, 2010). The objective of this study was to identify the level of incidence and severity of the common leaf diseases and dwarfism on 17 sweet corn genotypes and their impact on the crop productivity. The preliminary yield performance test of hybrids obtained from a half-diallel crossing of the eight inbred lines showed that 15 out of the 28 evaluated hybrids exhibited superior yield performance under organic cultivation conditions. These 15 hybrids were subsequently re-evaluated to assess their growth and

resistance to common sweet corn diseases in Indonesia, and the results were compared with two commercial varieties.

2. Materials and Methods

2.1 Study site and time

The study was conducted in a freshwater swampland soil located in a coastal area in the City of Bengkulu with an elevation of about 15 m asl from July 2024 to October 2024. The weather conditions during the experimentation were characterized by 26.8°C mean daily temperature, 84.1% mean daily relative humidity, and 288.5 mm monthly rainfall.

2.2 Planting materials

As the study's planting materials, fifteen experimental sweet corn hybrids bred for organic production were selected from half-diallel crossings of eight advanced inbred lines, namely (1) Caps2 × Caps5, (2) Caps2 × Caps22, (3) Caps3 × Caps17A, (4) Caps3 × Caps23, (5) Caps5 × Caps17A, (6) Caps5 × Caps17B, (7) Caps5 × Caps22, (8) Caps15 × Caps17A, (9) Caps15 × Caps22, (10) Caps15 × Caps23, (11) Caps17A × Caps17B, (12) Caps17A × Caps22, (13) Caps17B × Caps22, (14) Caps17B × Caps23, and (15) Caps22 × Caps23. Additionally, two commercial sweet corn hybrids, Paragon and Bonanza, were included as check varieties.

2.3 Design of experiment and crop management

A randomized complete block design (RCBD) with three replications was used to allocate the planting materials on the experimental plot. Five-meter-long double rows with 75-cm row spacing and 25-cm plant spacing made up the population of 48 plants within each plot. Cow manure at 5 t/ha was added to each plot one week prior to planting, and supplemental locally produced liquid organic fertilizer was sprayed on the leaves (Fahrurrozi et al., 2024) at two, three, four, five, six, seven, and eight-weeks after planting (WAP). Agrochemical products were not used to control weeds, diseases, or insect pests. The ear was harvested as soon as it reached the early dough stage, ranging from 75 to 80 DAP.

2.4 Data collection

Data for leaf disease incidence and severity were collected for leaf spot, eyespots, corn leaf blight, and corn rust at one, two and three months after planting. The collected data were then used to estimate the level of disease incidence (DI) and severity (DS) using the following equation.

$$DI = \frac{n}{N} \times 100\%$$

n= number of symptomatic leaves

N= leaf number/crop

Disease severity (DS) was calculated using the scoring method (Table 1) on a scale of 0-4 (Sariasih et al., 2024) with modification, and the formula calculated the severity of the disease based on severity formula.

Table 1. Disease severity rating scale of sweet corn foliar common disease

Severity scale	Description
0	No symptoms
1	<25% foliar common disease symptoms
2	25%-50% foliar common disease symptoms
3	> 50%-75% foliar common disease symptoms
4	> 75% foliar common disease symptoms

$$DS = \sum_{i=1}^k \frac{v_i \cdot n_i}{Z \cdot N} \times 100\%$$

vi: scale

ni: number of crops with a certain scale

Z: highest scale

N: Total number of crops observed

The results of the calculation of disease severity are grouped into resistance categories based on the research of Habibullah et al. (2020) shown in Table 2.

Table 2. Plant resistance categories based on disease severity

Resistance Category	Percentage of Diseases Severities (%)
Resistant	no symptoms
Moderately resistant	< 25%
Moderately susceptible	25%-50%
Susceptible	>50%-75%
Highly susceptible	>75%

(Habibullah et al., 2020)

The data of disease severity levels were further used to calculate the area under the disease progress curve (AUDPC) value for the three months of the study. The AUDPC was used to quantify disease intensity over time, as suggested by Madden et al. (2002), using the following equation.

$$AUDPC = \sum_{i=1}^{N-1} \frac{(y_i - y_{i+1})}{2} (t_i + 1 - t_{i+1})$$

y_i = the initial infection or the disease level at t_i.

t_i = time when initial infection happens.

(i.e., the first disease severity observation in our study).

AUDPC = the AUDPC at t_k is the total accumulated disease.

Data representing the characteristics of the crop productivity consisted of observation of ear length, ear diameter, ear weight (with and without husk), number of kernel rows, number of kernels per row, and husked ear yield per plot. The plant samples observed and collected per subplot consisted of five plants. The harvest yield was calculated based on the harvested area per subplot, with five-meter-long double rows with 75-cm row spacings and 25-cm plant spacings made up a population of 48 plants within each plot.

2.5 Data analysis

The collected data were subjected to analysis of variance post hoc utilizing Duncan's Multiple Range Test. All data analyses were performed using SPSS 26 software.

3. Results and Discussion

Sweet corn breeding programs are often aimed at obtaining corn seeds that have high productivity to meet national needs for corn. Some breeding programs for sweet corn hybrids were aimed at enhancing productivity while ensuring resistance to plant diseases (Shi et al., 2018; Zhang et al., 2022; Usman et al., 2024). However, in reality, the breeding activities of sweet corn plants are constrained by the attack of plant pest organisms, especially pathogens that attack sweet corn plants from the vegetative to generative period (Pataky et al., 1998; Shah & Dillard, 2006; Kainyu, 2014; Cao et al., 2024). The symptoms of the disease that appeared during the study were diseases that commonly attacked the leaves of sweet corn plants during the vegetative period. The symptoms of this disease certainly interfered with the growth of sweet corn and affected the corn generative period. Common foliar symptoms of diseases that appeared during the vegetative period of sweet corn are shown in Figure 1.

The symptoms observed on sweet corn leaves were typical of those affecting corn plants (Figure 1), including corn leaf spot, eyespot with halos, corn leaf light, and corn rust. These foliar diseases are primarily caused by fungal pathogens, as evidenced by the visible symptoms and the presence of hypha and mycelium. To assess disease resistance, the incidence and severity of the leaf diseases were measured, with a focus on identifying genotypes with the highest resistance during the vegetative stage. The disease incidence stages of sweet corn during three months after planting is detailed in Table 3.

Disease incidence generally increased over time for all hybrids, as shown by the higher percentages in the third month compared to the first and second months. Hybrid Caps22 × Caps23 had the highest disease incidence at the first stage, significantly differing from some hybrids. Similar to the two-month data, there were no significant differences among hybrids at this stage. At one month, hybrid Caps22 × Caps23 (33.99%) showed significantly different from hybrids Caps2 × Caps5, Caps2 × Caps22, Caps3 × Caps23, Caps5 × Caps17B, Caps15 × Caps22, and Caps17A × Caps22. At two and three months, there are no significant differences among the hybrids. Hybrid Caps22 × Caps23 consistently showed the highest disease incidence at 1 month, suggesting it may be more susceptible to the disease in the early stages. Hybrids Caps2 × Caps22 and Caps5 × Caps17B showed lower disease incidence in the early stages (one and two months), indicating potential resistance or tolerance to the disease. Hybrid Caps15 × Caps17A had the lowest disease incidence at three months (23.29%), suggesting some level of resistance as the disease progressed. The hybrids with lower disease incidence in the early stages (hybrids Caps2 × Caps22 and Caps5 × Caps17B), and the last stages (hybrid Caps15 × Caps17A and Caps5 × Caps17A) may be more promising for further evaluation or cultivation in areas prone to foliar diseases.

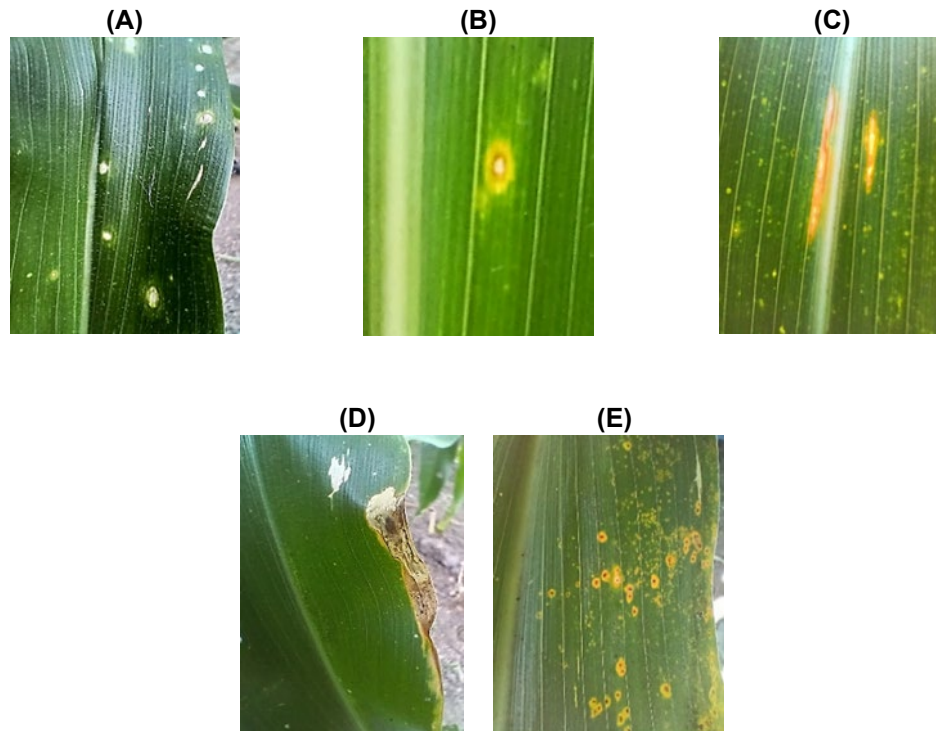


Figure 1. Common foliar disease of sweet corn. A: corn leaf spot, B: eyespots with halos, C-D: corn leaf blight, E: corn rust

The lack of significant differences at two and three months suggested that disease incidence became more uniform over time, possibly due to the progression of the disease or environmental factors. Hybrid Caps22 × Caps23, with the highest disease incidence at one month, may require further investigation to understand its susceptibility. An interesting fact about the incidence of this disease is that there were two hybrids that showed a lower disease incidence than commercial seeds, Paragon and Bonanza. This showed that the seven hybrid seeds had better resistance than commercial seeds. Incidence among different hybrids, with Caps2 × Caps22 and Caps5 × Caps17B consistently exhibiting lower disease severity and incidence, indicating potential resistance. These findings align with previous studies emphasizing the importance of genetic factors in disease resistance (Pataky et al., 1998; Mirsam et al., 2023). The presence of fungal pathogens, such as those causing corn leaf spot and rust, significantly impacted plant health, supporting the established understanding of fungal threats to maize crops (Muis et al., 2022; Cao et al., 2024).

Disease severity generally increased over time for all hybrids, as shown by the higher percentages in the third month compared to the first and second months. Hybrid Caps15 × Caps17A showed the highest disease severity at the first stage, significantly differing from some hybrids (Caps2 × Caps22 and Caps5 × Caps17B). At the second and final stages, Caps17A × Caps22 had the highest disease severity, which was significantly different from that of some hybrids, and on average over the three months, this hybrid also exhibited the highest disease severity compared to the others (Table 4).

Table 3. Disease incidence stages of sweet corn during the three months after planting

Hybrid Number	Disease Incidence Month after Planting (%)		
	1	2	3
Caps2 × Caps5	18.32 ^a	21.19 ^a	29.07 ^a
Caps2 × Caps22	15.54 ^a	17.31 ^a	25.04 ^a
Caps3 × Caps17A	22.28 ^{ab}	18.95 ^a	27.76 ^a
Caps3 × Caps23	17.86 ^a	19.25 ^a	32.17 ^a
Caps5 × Caps17A	22.17 ^{ab}	14.73 ^a	24.98 ^a
Caps5 × Caps17B	15.56 ^a	21.88 ^a	30.96 ^a
Caps5 × Caps22	20.69 ^{ab}	18.59 ^a	26.22 ^a
Caps15 × Caps17A	27.84 ^{ab}	19.45 ^a	23.29 ^a
Caps15 × Caps22	17.63 ^a	20.65 ^a	29.53 ^a
Caps15 × Caps23	22.86 ^{ab}	18.92 ^a	26.18 ^a
Caps17A × Caps17B	22.62 ^{ab}	17.35 ^a	27.40 ^a
Caps17A × Caps22	16.40 ^a	20.47 ^a	30.18 ^a
Caps17B × Caps22	26.28 ^{ab}	23.64 ^a	31.29 ^a
Caps17B × Caps23	20.80 ^{ab}	17.95 ^a	29.84 ^a
Caps22 × Caps23	33.99 ^b	18.87 ^a	27.43 ^a
Paragon	20.68 ^{ab}	19.53 ^a	28.00 ^a
Bonanza	24.98 ^{ab}	20.39 ^a	25.72 ^a

Means followed by the same letter within a column are not significantly different at $p \geq 0.05$ according to Duncan's Multiple Range Test.

Table 4. Severity stages of common foliar diseases in sweet corn hybrids

Hybrid	Month after Planting (%)		
	1	2	3
Caps2 × Caps5	4.82 ^{ab}	10.85 ^{ab}	17.85 ^a
Caps2 × Caps22	3.92 ^a	9.22 ^a	15.84 ^a
Caps3 × Caps17A	5.53 ^{ab}	12.76 ^{ab}	18.24 ^a
Caps3 × Caps23	4.63 ^{ab}	12.35 ^{ab}	16.23 ^a
Caps5 × Caps17A,	5.53 ^{ab}	9.48 ^a	16.11 ^a
Caps5 × Caps17B	3.92 ^a	15.16 ^{ab}	21.24 ^a
Caps5 × Caps22	5.39 ^{ab}	12.06 ^{ab}	16.94 ^a
Caps15 × Caps17A	8.97 ^b	10.71 ^{ab}	16.04 ^a
Caps15 × Caps22	4.46 ^{ab}	13.42 ^{ab}	19.33 ^a
Caps15 × Caps23	5.46 ^{ab}	11.15 ^{ab}	16.30 ^a
Caps17A × Caps17B	5.75 ^{ab}	10.10 ^{ab}	15.17 ^a
Caps17A × Caps22	4.46 ^{ab}	16.59 ^b	21.67 ^a
Caps17B × Caps22	7.17 ^{ab}	15.21 ^{ab}	20.13 ^a
Caps17B × Caps23	5.24 ^{ab}	13.25 ^{ab}	20.74 ^a
Caps22 × Caps23	8.50 ^{ab}	11.15 ^{ab}	17.88 ^a
Paragon	5.18 ^{ab}	13.18 ^{ab}	17.65 ^a
Bonanza	5.66 ^{ab}	13.31 ^{ab}	19.54 ^a

Means followed by the same letter within a column are not significantly different at $p \geq 0.05$ according to Duncan's Multiple Range Test.

Hybrids Caps2 × Caps22 and Caps5 × Caps17B consistently showed lower disease severity in the early stage (one month), suggesting potential resistance or tolerance to the disease. Hybrid Caps17A × Caps22 exhibited the highest disease severity at two and three months, indicating it may be more susceptible to the foliar disease. Hybrids with lower disease severity in the early stage and the last stages may be more promising for further evaluation or cultivation in areas prone to foliar diseases. The lack of significant differences at three months suggested that disease severity converged over time, possibly due to the progression of the disease or environmental factors. An interesting fact about the severity of this disease is that there were seven hybrids that had lower incidence of disease than commercial seeds in samples of Paragon and Bonanza. This showed that the seven hybrid seeds had better resistance than commercial seeds. Plant resistance categories were classified based on disease severity values according to Habibullah et al. (2020) where hybrids exhibiting disease severity of less than 25% were categorized as moderately resistant.

In addition to disease severity and incidence data, the AUDPC (*Area Under the Disease Progress Curve*) value or infection rate of plant diseases was also calculated where the lower the AUDPC value, the higher the plant's resistance to disease. AUDPC value data is shown in Figure 2. The AUDPC values in the bar chart represent the cumulative disease severity over time for different sweet corn hybrids. Higher AUDPC values indicate greater overall disease impact, while lower values suggest better resistance or slower disease progression. Hybrid Caps3 × Caps17B had the highest AUDPC value (32.45 %), highlighted in red, indicating it was the most susceptible to foliar disease. Hybrid Caps2 × Caps22 has the lowest AUDPC value (21.07%). Hybrids Caps22 × Caps23 and Caps15 × Caps17A also had high AUDPC values (31.89% and 29.70%, respectively). Hybrids with high AUDPC values are more susceptible to foliar disease. Hybrid Caps2 × Caps22, with the lowest AUDPC, might have better disease resistance. Selecting lower-AUDPC hybrids can be useful for breeding disease-resistant sweet corn varieties. The AUDPC values further reinforced the resistance levels of hybrids, with Caps2 × Caps22 exhibiting the lowest AUDPC value, suggesting greater resistance compared to more susceptible hybrids like Caps 3 × Caps17B. These findings highlight the need for selecting hybrids with lower AUDPC values in breeding programs to develop disease-resistant sweet corn varieties (Pataky et al., 1998; Usman et al., 2024).

Another disease symptom found in the study field was variegated symptom on the leaves, which were similar to downy mildew, but the plants with this symptom become dwarfed (Figure 3). Symptoms of dwarfism are usually caused by viral pathogens, but to ascertain the type of pathogen involved, further molecular identification is needed.

The number of dwarfs with variegated symptoms is shown in Figure 4. Observation data were taken from one month to three months after planting. Hybrids Caps3 × Caps17A, Caps15 × Caps22, Caps17A × Caps22, and Caps17B × Caps23 did not show any dwarfing throughout the observation period. These hybrids might have better vigor or resistance to stress factors causing dwarfing. Hybrids Caps2 × Caps5, Caps5 × Caps22, Caps15 × Caps17A, Caps22 × Caps23, and Bonanza showed consistent dwarfing from the first to the third month. Although dwarfing increased in the second month, it remained constant in the Hybrid Caps2 × Caps5, Caps2 × Caps22, Caps3 × Caps23, Caps5 × Caps17A, Caps5 × Caps22, Caps15 × Caps23, Paragon, and Bonanza. While Hybrid Caps17A × Caps17B had a gradual increase, with the highest number of dwarfs in the third month.

The increased incidence of virus induced dwarfism in the Bonanza hybrid may relate to its leaf color and attractiveness to insect vectors of dwarfism disease. Bonanza is known for its vigorous growth and dark green foliage, which may inadvertently serve as a visual or physiological cue that attracts insect vectors such as aphids and planthoppers.

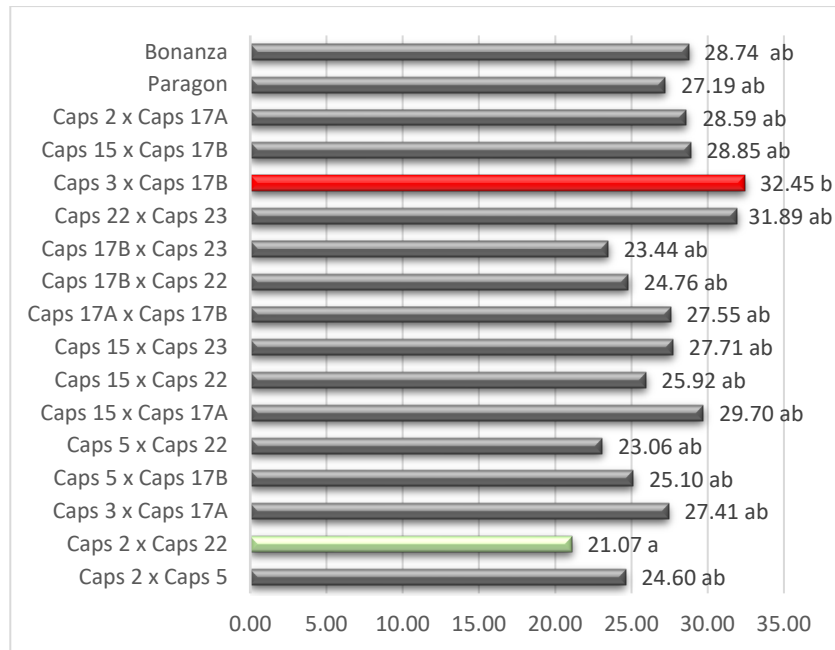


Figure 2. Area under disease progress curve (AUDPC) percentage of common foliar disease

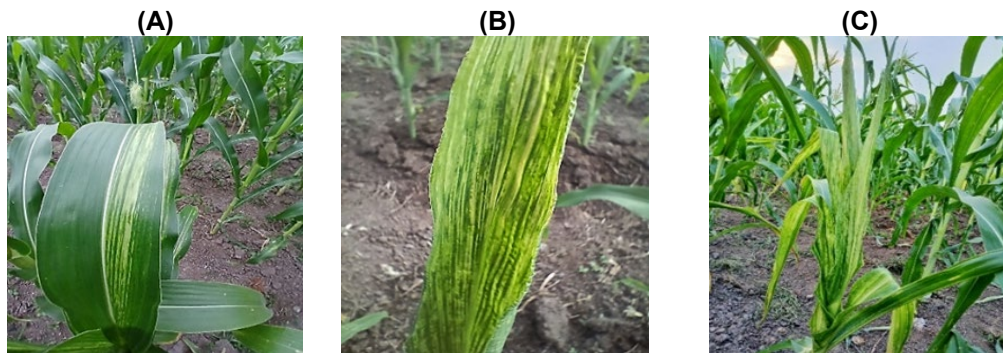


Figure 3. A: Early symptoms of chlorosis/varigate in leaf, B: Advanced symptoms of chlorosis/varigate, C. Dwarfing symptoms

At the end of the observation, the data analysis result of the sweet corn yield and the yield data are displayed in Table 5 with variables ear diameter (with and without husk), and ear length (with and without husk). The highest ear diameter with husk was recorded in commercial Paragon hybrid (57.30 mm), followed by Caps15 × Caps23 (56.73 mm). Meanwhile, the largest ear diameter without husk was observed in Paragon hybrid (49.93 mm), followed by Caps22 × Caps23 and Caps15 × Caps17A (49.00 mm) hybrids. The longest ear length with husk was found in Caps 17A × Caps 17B (29.83 mm), followed by Caps17A × Caps22 (27.63 mm) and Caps15 × Caps17A (27.13 mm) hybrids.

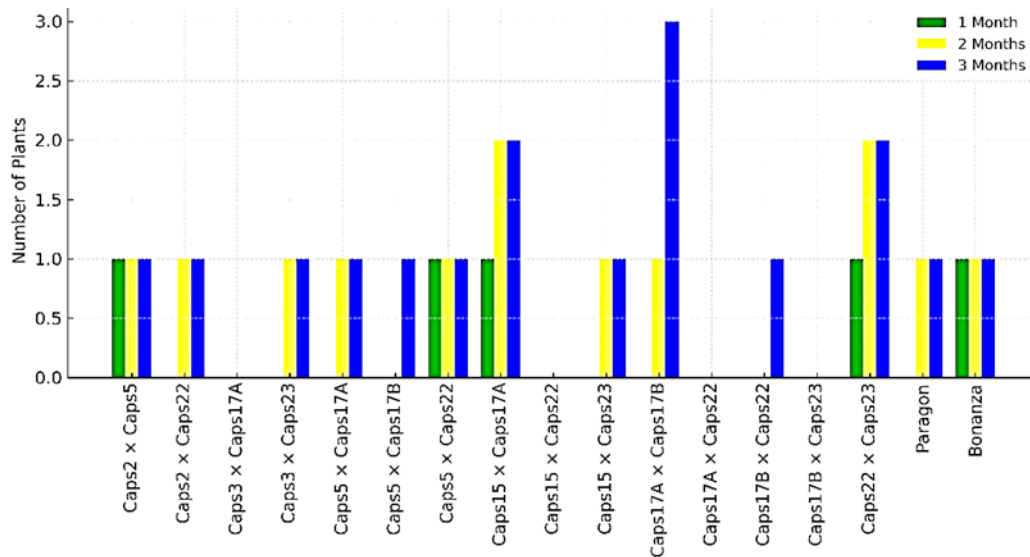


Figure 4. The number of dwarfed and varigated plants over the three months after planting

Table 5. Ear diameter and ear length of different sweet corn genotypes

Genotype	Ear Diameter (mm)		Ear Length (cm)	
	With Husk	No Husk	With Husk	No Husk
Caps2 x Caps5	55.67 ^{abc}	48.57 ^{ab}	25.47 ^{abc}	18.43 ^{ab}
Caps2 x Caps22	49.17 ^{ab}	43.67 ^a	23.57 ^{ab}	17.97 ^{ab}
Caps3 x Caps17A	53.37 ^{abc}	46.67 ^{ab}	24.00 ^{abc}	17.73 ^{ab}
Caps3 x Caps23	51.23 ^{abc}	46.67 ^{ab}	25.17 ^{abc}	18.83 ^{ab}
Caps5 x Caps17A	52.77 ^{abc}	44.70 ^{ab}	25.53 ^{abc}	20.10 ^b
Caps5 x Caps17B	55.73 ^{abc}	48.33 ^{ab}	26.30 ^{bcd}	20.07 ^b
Caps5 x Caps22	51.37 ^{abc}	44.43 ^{ab}	24.87 ^{abc}	18.83 ^{ab}
Caps15 x Caps17A	56.00 ^{abc}	49.00 ^b	27.13 ^{bcd}	17.13 ^a
Caps15 x Caps22	48.50 ^a	42.87 ^a	24.87 ^{abc}	18.43 ^{ab}
Caps15 x Caps23	56.73 ^{bc}	47.27 ^{ab}	26.03 ^{abc}	19.33 ^{ab}
Caps17A x Caps17B	55.13 ^{abc}	47.57 ^{ab}	29.83 ^d	19.33 ^{ab}
Caps17A x Caps22	55.13 ^{abc}	47.50 ^{ab}	27.63 ^{cd}	19.03 ^{ab}
Caps17B x Caps22	52.23 ^{abc}	45.73 ^{ab}	24.40 ^{abc}	18.27 ^{ab}
Caps17B x Caps23	52.73 ^{abc}	46.33 ^{ab}	24.47 ^{abc}	20.23 ^b
Caps22 x Caps23	55.77 ^{abc}	49.00 ^{ab}	24.23 ^{abc}	18.63 ^{ab}
Paragon	57.30 ^c	49.93 ^b	26.20 ^{bcd}	19.80 ^b
Bonanza	52.20 ^{abc}	47.60 ^{ab}	22.20 ^a	17.90 ^{ab}

Means followed by the same letter within a column are not significantly different at $p \geq 0.05$ according to Duncan's Multiple Range Test.

The longest ear without husk was in Caps17B × Caps23 (20.23 cm) and Caps5 × Caps17A (20.10 cm), suggesting better ear development. Bonanza showed a smaller ear length (22.20 cm with husk), which was significantly different from some hybrid crosses. The additional yield variables, including the number of kernel rows and the number of kernels per row, are presented in Figure 5.

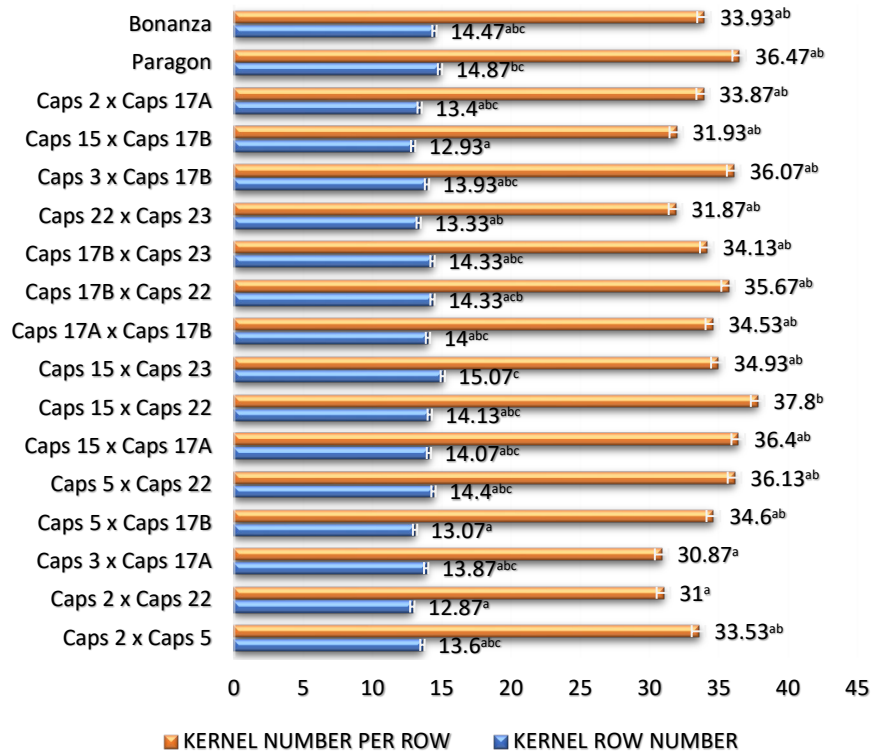


Figure 5. Kernel row number (blue) and kernel number per row (red) of sweet corn genotypes. Treatment means with the same letter are not significantly different ($p \geq 0.05$) based on Duncan's test.

The highest kernel row number was observed in Caps15 × Caps23 (15.07 rows) and the lowest kernel row number was observed in Caps2 × Caps 22 (12.87 rows), which were significantly different. Meanwhile, the highest kernel number per row was observed in Caps15 × Caps22 (37.80 kernels), and the lowest kernel row number was observed in Caps3 × Caps17A (30.87 kernels). The results of the statistical analysis in these cases were significantly different. These findings were essential for selecting superior hybrids with enhanced kernel formation, which directly influences sweet corn yield and quality.

Paragon hybrid generally performed better than Bonanza hybrid in both kernel number per row and kernel row number. Some hybrids, particularly Caps15 × Caps23, had higher kernel row numbers than both commercial varieties, suggesting potential for better yield. The subsequent yield variables examined were ear weight and kernel weight of sweet corn across all tested genotypes (Table 6).

Table 6. Ear and kernel weight of sweet corn yield for all tested genotypes

Genotype	Ear Weight			Grain Yield/ha (ton)
	With Husk /Plot (Kg)	With Husk/Ear (G)	No Husk/Ear (G)	
Caps2 × Caps5	4.11 ^a	260.60 ^{abc}	198.40 ^{abc}	13.90 ^{abc}
Caps2 × Caps22	5.06 ^{abc}	205.13 ^a	167.93 ^{ab}	10.94 ^a
Caps3 × Caps17A	4.82 ^{abc}	236.33 ^{ab}	179.27 ^{abc}	12.61 ^{ab}
Caps3 × Caps23	6.33 ^{abc}	231.80 ^{ab}	185.80 ^{abc}	12.36 ^{ab}
Caps5 × Caps17A	6.79 ^{abc}	292.40 ^{bc}	223.07 ^{cd}	15.59 ^{bc}
Caps5 × Caps17B	5.31 ^{abc}	297.87 ^{bc}	212.67 ^{bc}	15.87 ^{bc}
Caps5 × Caps22	4.21 ^{ab}	256.00 ^{abc}	202.60 ^{abc}	13.65 ^{abc}
Caps15 × Caps17A	6.18 ^{abc}	280.73 ^{abc}	215.47 ^{bcd}	14.97 ^{abc}
Caps15 × Caps22	5.75 ^{abc}	203.93 ^a	153.67 ^a	10.87 ^a
Caps15 × Caps23	5.72 ^{abc}	300.93 ^{bc}	214.40 ^{bcd}	16.05 ^{bc}
Caps17A × Caps17B	6.99 ^c	278.13 ^{abc}	199.33 ^{abc}	14.84 ^{abc}
Caps17A × Caps22	4.80 ^{abc}	281.27 ^{abc}	198.47 ^{abc}	15.00 ^{abc}
Caps17B × Caps22	5.89 ^{abc}	251.07 ^{ab}	185.27 ^{abc}	13.39 ^{ab}
Caps17B × Caps23	5.37 ^{abc}	241.47 ^{ab}	179.13 ^{abc}	12.88 ^{ab}
Caps22 × Caps23	6.10 ^{abc}	259.20 ^{abc}	202.13 ^{abc}	13.82 ^{abc}
Paragon	5.83 ^{abc}	335.07 ^c	263.53 ^d	17.87 ^c
Bonanza	6.88 ^{bc}	248.73 ^{ab}	194.07 ^{abc}	13.27 ^{ab}

Means followed by the same letter within a column are not significantly different at $p \geq 0.05$ according to Duncan's Multiple Range Test.

The highest ear weight with husk per plot was Caps17A x Caps17B (6.99 kg/plot), which was higher than Bonanza and Paragon. Meanwhile, Paragon had the highest ear weight per ear, with and without husk of 335.07 g/ear and 263.53 g/ear, respectively. Paragon also had the highest grain yield, 17.87 ton/ha (significantly highest, marked with c) followed by hybrid Caps15 × Caps23: 16.05 ton/ha, Caps5 × Caps17B: 15.87 ton/ha, and Caps5 × Caps17A: 15.59 ton/ha.

The next parameter measured was the sweetness level of the harvested sweet corn. The data, along with the results of the statistical analysis, are presented in Figure 6. The commercial variety Bonanza was shown to exhibit the highest sweetness level (12), which was significantly higher than most hybrid genotypes, confirming its status as the sweetest variety. Paragon was also among the sweetest genotypes (11.67); however, its statistical grouping slightly overlapped with other hybrids, suggesting that while it demonstrated superior sweetness, the difference was not statistically significant in comparison to some hybrids (Figure 6).

Most hybrid combinations fell within the 8.33-10.67 range and shared overlapping statistical groups, indicating no significant differences among many of them. The lowest sweetness level was recorded at 8.33 (Caps 15 x Caps 23), which is statistically different from the highest values but not necessarily different from many mid-range hybrids.

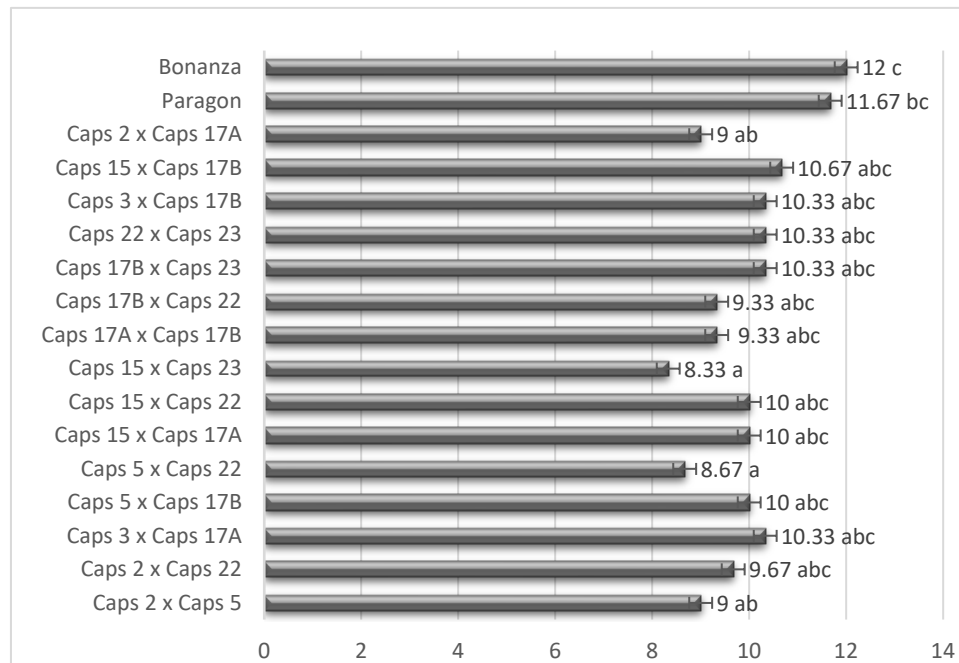


Figure 6. Sweetness level of sweet corn for all genotypes. Treatment means with the same letter are not significantly different ($p \geq 0.05$) based on Duncan's test.

In terms of agronomic performance, hybrids Caps15 × Caps23 and Caps17B × Caps23 demonstrated superior ear diameter and length, which are essential traits for market acceptance. The positive correlation between ear size and grain yield aligned with previous reports indicating that ear morphology directly affected yield potential. However, sweetness levels varied among hybrids, with commercial varieties like Paragon showing the highest sugar content. This suggests that while yield traits can be improved through breeding, achieving high sweetness levels may require additional selection for sugar-related genetic traits (Fahrurrozi et al., 2024; Usman et al., 2024).

4. Conclusions

This study highlights the critical role of disease resistance in the development of high-yielding sweet corn hybrids. Correlation analysis revealed that ear morphological traits, particularly ear weight, diameter, and kernel number were key determinants of grain yield in sweet corn. Yield was strongly and positively associated with these traits, while disease severity exhibited a significant negative correlation with the yield-related parameters. These findings confirm that foliar diseases substantially reduce productivity by impairing photosynthesis and nutrient distribution. Among the tested genotypes, Caps15 × Caps23 demonstrated the most favorable balance between high yield and moderate disease severity, indicating partial tolerance without compromising productivity. This suggests that integrating disease resistance into breeding programs is a viable strategy to sustain yield under pathogen pressure. Overall, the results emphasize the importance of developing and promoting high yielding and disease tolerant hybrids to enhance sweet corn performance and ensure sustainable production in disease prone environments.

5. Acknowledgements

The Directorate General of Higher Education, Ministry of Education and Culture of the Republic of Indonesia provided financial assistance for this work as part of the Applied Research Scheme [Grant number 043/E5/PG.02.00.PL/2024].

6. Authors' Contributions

Yenny Sariasih worked on the study idea, data collection, analysis, and writing the manuscript. **Sempurna Ginting** and **Mimi Sutrawati** helped with data collection and verification and manuscript preparation, and **Mohammad Chozin** contributed to the experimental setting, material preparation, and manuscript reviewing. **Sigit Sudjarmiko** and **Fahrurrozi Fahrurrozi** contributed to the manuscript editing and reviewing.

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7. Conflicts of Interest

The authors declare that they have no conflict of interest.

8. AI Declaration

The authors periodically used Google Translate when preparing this manuscript to make sure the right English expressions were used. The authors (Fahrurrozi Fahrurrozi, Sempurna Ginting, Mimi Sutrawati, Mohammad Chozin, Sigit Sudjarmiko, and Yenny Sariasih) took full responsibility for the final content of the published article after using this tool/service. They also thoroughly paraphrased, reviewed, and edited the content as needed.

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