

Thesis of Doctoral (Ph.D.) Dissertation

**EFFECT OF DIFFERENT SOWING DATES, NITROGEN FERTILIZERS, AND
PLANT DENSITIES ON YIELD OF SWEET CORN (ZEA MAYS L.
SACCHARATA).**

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1. INTRODUCTION

Sweet corn (*Zea mays L. saccharata*) is a widely cultivated crop known for its high nutritional value and economic importance. The optimization of its yield is a critical area of research, particularly in relation to the management of agronomic practices such as sowing dates, nitrogen fertilization, and plant densities. The interactions between these variables significantly influence crop growth, development, and productivity, affecting the quality and quantity of the final harvest (Landa,2024). Sweet corn is highly sensitive to environmental conditions, and the proper management of sowing time, nitrogen application, and plant density is crucial to achieving optimal yields (Tang, 2025). As such, understanding the interactions between these factors is essential for improving sweet corn productivity under varying agroecological conditions.

The sowing date is a fundamental factor that impacts the growth and yield of sweet corn. The timing of sowing influences several key factors such as soil temperature, moisture availability, and light intensity, all of which can affect germination, vegetative growth, and reproductive stages (Franco, 2016). Early sowing can sometimes lead to better crop establishment, but it may also expose the plants to the risk of frost damage, especially in temperate regions (Pandey, 2023). On the other hand, late sowing can result in reduced yield due to suboptimal growing conditions, such as higher temperatures or reduced rainfall (Wheeler,2000). Therefore, identifying the optimal sowing window is essential for maximizing sweet corn yields. Numerous studies have shown that sowing dates must be adjusted based on local climatic conditions to avoid risks associated with temperature extremes, which can negatively affect the crop's development (Franco,2016).

The application of nitrogen fertilizers plays a crucial role in the growth and productivity of sweet corn. Nitrogen is an essential macronutrient that influences plant growth, photosynthesis, and the development of kernels (Fathi,2022). Nitrogen deficiency can lead to poor plant growth, reduced chlorophyll production, and low yields, while excessive nitrogen can lead to excessive vegetative growth at the expense of reproductive growth, thereby reducing kernel formation and overall yield (Leghari, 2016). Research has shown that the right amount of nitrogen fertilizer applied at the correct stages of growth can significantly enhance yield and improve the overall quality of the crop (Fathi, 2022).

Moreover, studies have found that nitrogen applications need to be tailored to specific growth stages to optimize sweet corn yields, as both early and late nitrogen applications can have different effects on plant development (Patel, 2021).

Optimal nitrogen management practices are essential for achieving high nitrogen use efficiency, minimizing environmental pollution, and ensuring sustainable sweet corn production (Ren, 2022).

Plant density is another critical factor influencing sweet corn yields. Higher plant densities often result in more competition for light, water, and nutrients, which can reduce the yield potential if not properly managed (Shi, 2016). On the other hand, lower plant densities may result in underutilization of the available space, leading to reduced yields (Zhang, 2021). The optimum plant density varies with factors such as nitrogen availability, soil fertility, and water supply (Chen, 2022). Some studies suggest that increasing plant density can improve the yield per unit area by enhancing the number of plants, but this must be balanced with sufficient nutrient and water availability (Chen, 2022). In regions where water and nutrients are not limited, increasing plant density may lead to higher yields, as the increased competition for resources can be managed by optimizing fertilizer and irrigation practices (Dai, 2022). However, under dry conditions or in nutrient-poor soils, higher plant densities may exacerbate resource competition and result in decreased productivity (Zhang, 2021).

The interactions between sowing dates, nitrogen fertilizers, and plant densities are complex and vary across different environmental conditions. In temperate climates, where early sowing is preferred, applying nitrogen at appropriate times can mitigate the negative effects of late-season water stress or temperature fluctuations (Nazeri, 2021). Additionally, adjusting plant density according to nitrogen availability has been shown to improve resource use efficiency, thereby boosting sweet corn yields (Zhang, 2020). These interactions suggest that optimizing multiple factors simultaneously, such as planting time, nitrogen application, and plant density, is key to maximizing the yield potential of sweet corn.

In conclusion, the yield of sweet corn is heavily influenced by sowing dates, nitrogen fertilization, and plant density. Each of these factors plays a vital role in ensuring optimal growth conditions for sweet corn, and their interactions can have significant implications for yield and quality. Future research should continue to focus on fine-tuning these agronomic practices to achieve higher yields while maintaining sustainable agricultural practices.

By adjusting these factors according to the specific environmental conditions and understanding their interactions, farmers can improve the efficiency of sweet corn production, contributing to both food security and economic growth (*Williams,2008*).

Objectives

The objectives of this research are:

1. To determine the optimum sowing dates of sweet corn hybrids.
- 2 . The study was to determine the best plant density for sweet corn yield and morphological characters.
3. The purpose of this research is to investigate the effect of Nitrogen fertilizer on the growth and yield of sweet corn.
4. Determine yield components through correlation and path coefficient analyses so the breeders can utilize them to develop new sweet corn hybrids with high yields.
5. To estimate the yield potential of different sweet corn hybrids.
6. To evaluate different sweet corn hybrids on different characters.
7. To determine Regression, factor analysis, and cluster analysis between different sweet corn hybrids.
8. Determination of the highest yield and maximum desirability in maize hybrids.

2. MATERIALS AND METHODS

2.1 Effect of Different Levels of Nitrogen Fertilizer and Plant Densities on Sweet Corn Yield (2022)

A factorial experiment was conducted at the Látókép Research Center, Debrecen University, using a randomized complete block design with four replications. The study evaluated four sweet corn hybrids (SF1379, Tyson, GSS6924, Messenger) under three nitrogen levels (100, 150, 200 kg N/ha) and three plant densities (60,000, 70,000, 80,000 plants/ha). The soil was calcareous chernozem with a near-neutral pH. Soil preparation included plowing and fertilization with NPK (8:24:24) and Pétió (27% N). Irrigation was applied six times. Growth and yield parameters, such as plant height(cm), silking/tasselling time, Number/cob, diameter/ear(mm), length/ear(cm), Yield kg/ha, Number/rows, Number/kennels, moisture%, and grain yield, Emergence%, phenological stage (6/leaves), were recorded. Harvest occurred in late July to early August 2022.

2.2 Effect of Different Sowing Dates on the Yield Performance of Sweet corn hybrids (2022)

Sweet corn hybrids (SF1379, Braveheart, Tyson, Messenger) were examined under three sowing dates (April 27, May 31, June 29) with four replications. The plots were four-row designs, and the 2nd and 3rd rows were assessed post-harvest. Standard agronomic practices, including fertilization, irrigation, and plant protection, were applied. Growth and yield components were measured, and harvesting dates ranged from July to October 2022.

2.3 Influence of Different Sowing Dates on Yield of Sweet Corn Hybrids (2023)

Four hybrids (Azlan, HMX825, Braveheart, GSS3071) were tested under four sowing dates (April 30, May 30, June 30, July 15) with four replications. The experimental design followed standard agronomic techniques, including fertilization (500 kg/ha CAN 27% N), irrigation, and plant protection (Force 1.5 G, Laudis, Coragen 20 SC, Karate Zeon 5 CS). Growth and yield parameters were measured, with harvesting occurring from July to October 2023.

2.5 Assessment of Yield Potential in Five Sweet Corn Hybrids (2023 Growing Season)

Five sweet corn hybrids (Spirit, Azlan, GSS6924, Impress, Dessert78) were tested under full irrigation with four replications. Plowing was conducted on 11 October 2022, followed by soil preparation in March and April 2023. Sowing occurred on 16 May 2023, with fertilization applied in April, May, and June. Irrigation was provided in four cycles (3-25 July), and plant

protection included soil disinfection, herbicides, and insecticides. Harvesting took place between 14-21 August 2023, with measurements on plant growth, yield, and quality.

2.6 Influence of Different Nitrogen Fertilizer Levels on Yield of Sweet Corn Hybrids (2023 Season)

Five sweet corn hybrids (GSS6924, Royalty, Spirit, Azlan, GSS5649) were tested under three nitrogen treatments: single (100 kg/ha), split into two (50+50 kg/ha), and split into three (33.3+33.3+33.3 kg/ha). The experiment followed full irrigation with four replications. Soil preparation included plowing on 11 October 2022 and combinator operations in March and April 2023. Sowing was conducted on 28 April 2023, with fertilization and plant protection applied as per treatment specifications. Irrigation followed the same schedule as the yield potential experiment. Harvesting took place between 21 July and 3 August 2023, with data collection on plant growth, yield, and quality attributes.

2.7 Comparative Evaluation of Yield in Various Sweet Corn Hybrids (2023 Season)

Thirty-two hybrids were tested in a single replicate under full irrigation. Each plot consisted of two 10-meter rows. The experiment was conducted in two sowing phases (28 April and 29 May 2023). Soil preparation followed plowing on 11 October 2022, with subsequent cultivation operations in March and April 2023. Fertilization included CAN (27% N) at 500 kg/ha on 26 April 2023. Plant protection treatments involved soil disinfection, herbicides, and insecticides applications. Irrigation followed the same schedule as in previous experiments. Harvesting was conducted between 21 July and 29 August 2023. Measured parameters included plant development, yield, and quality characteristics.

2.8 Weather characteristics of the 2022 growing season (Debrecen-Látókép)

Following the very dry 2021 growing season, there was also little rainfall in the winter period. The 144 mm of precipitation over six months is 70 mm below the multi-year average. The period was slightly colder but significantly richer in sunshine than usual (Table 1). The replenishment of the deeper soil layers was not satisfactory. The total rainfall of 32 mm from January to March, combined with sunny and windy weather, also strongly contributed to the drying of the upper soil layers, which raised the prospect of an even more severe drought.

Table 1 Monthly and semi-annual characteristics of temperature, precipitation (Debrecen-Látókép), and solar radiation (Debrecen, OMSZ) in 2022

period	mean temperature	precipitation (mm)	Sunshine duration (hours)
winter period (X-III)		144 (-70)	891 (+217)
summer period (IV-IX)	18.5 (+1.0)	268 (-78)	1566 (+50)
April	9.0 (-2.2)	53 (-3)	177 (-37)
May	17.6 (+1.0)	10 (-54)	275 (+25)
June	22.2 (+2.9)	17 (-49)	358 (+89)
July	23.4 (+2.1)	22 (-44)	312 (+26)
August	23.5 (+2.7)	17 (-32)	303 (+14)
September	15.3 (-0.9)	152 (+104)	141 (-67)

Due to the drought, spring soil work could be carried out everywhere in March. April was marked by slightly cool weather with average rainfall. For the whole growing season, April showed the largest negative temperature anomaly, with a mean temperature of 9.0°C, i.e., 2.2°C below the average, but less cool than April 2021. In contrast, there was warm and dry weather in May from the beginning of the month. Overall, conditions for sowing and emergence were favorable in spring 2022.

The daily mean soil temperatures rose steadily above the base temperature of the crop (10°C) from the 12th of April and reached a stable 15°C by the end of the month. Air temperatures remained several degrees below soil temperature on all except a few days, with a clear soil temperature surplus.

3. RESULTS

3.1 Effect of Different levels of Nitrogen Fertilizer on the Yield of Four sweet corn Hybrids, Season 2022.

The analysis of variance revealed significant effects of nitrogen levels and hybrids on sweet corn yield and related traits. The interaction between hybrids and nitrogen levels significantly influenced emergence percentage, while other measured traits, such as the number of cobs, moisture content, number of plants, and number of rows, exhibited varying degrees of significance. Among the nitrogen treatments, 100 kg N/ha was found to be the optimal dose, while higher doses (150-200 kg N/ha) resulted in yield reductions.

LSD analysis showed that the hybrid *Messenger* achieved the highest emergence percentage (80.22%) and yield (17,494 kg/ha), while *SF1379* had the lowest values for both traits. *Tyson* recorded the greatest ear diameter (52.98 mm), while *GSS6924* exhibited the tallest plant height (185.6 cm). The highest number of kernels was found in *SF1379* (42.92), while *Tyson* had the highest number of rows per ear (19.93). The results are presented in Table 2 and Figures 2,3.

Correlation analysis indicated a strong positive relationship between key growth parameters, including emergence percentage, plant height, and yield components. The number of cobs exhibited a significant correlation with yield ($r = 0.911^{**}$), highlighting its importance in sweet corn production. Additionally, plant height correlated positively with several yield-related traits, including ear diameter and kernel number, suggesting their potential as selection criteria in breeding programs. Moisture content also showed positive correlations with emergence percentage and other phenological traits. Overall, the results emphasize the importance of nitrogen management in optimizing sweet corn productivity. The study supports the effectiveness of moderate nitrogen application (100 kg N/ha) in improving yield and nitrogen use efficiency while minimizing adverse effects associated with excessive fertilization.

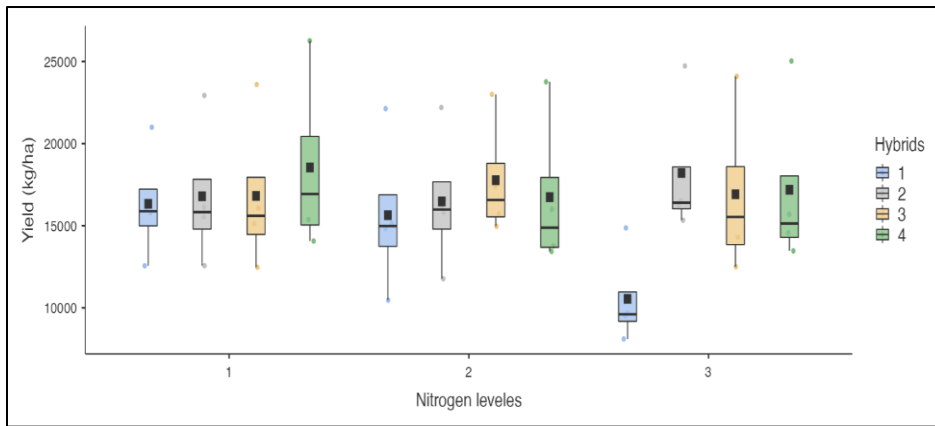


Figure 1 Effect of different doses of nitrogen fertilizer on yield kg/ha of different sweet corn hybrids, 2022

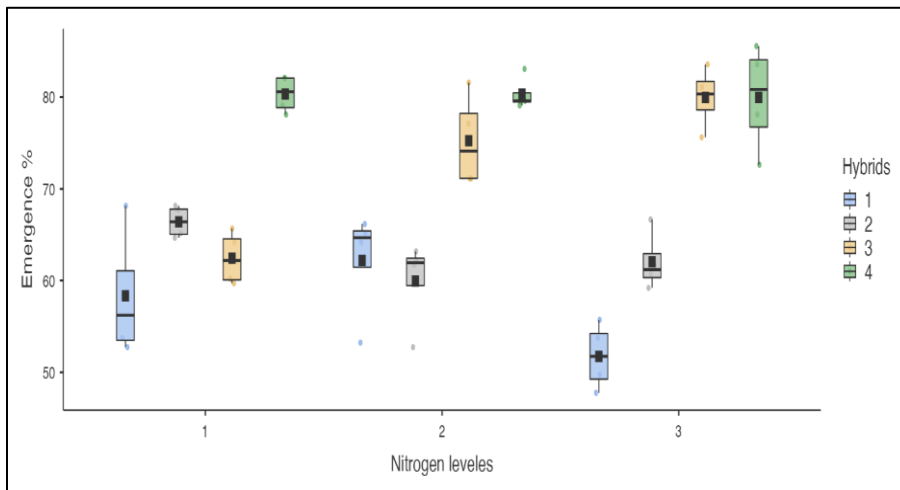


Figure 2 Effect of different levels of Nitrogen fertilizer on the emergence % of different sweet corn hybrids, 2022

Table 2 LSD% test on parameters of different levels of Nitrogen fertilizer of sweet corn hybrids

Hybrids	Number/rows	Group	Amount%	Group	Emergence%	Group
SF1379	17.52	a	37.166	b	57.42	a
Tyson	19.93	c	35.70	a	62.81	b
GSS6924	18.85	b	36.31	ab	72.55	c
Messenger	17.85	a	36.53	ab	80.22	d
Hybrids	Number/cobs	Group	Yield kg/ha	Group	Grain yield(g)	Group
SF1379	59.25	a	14172	a	1.524	a
Tyson	64.25	a	17163	a	1.518	a
GSS6924	67.25	ab	17169	a	1.445	a
Messenger	74.75	b	17494	a	1.4889	a
Hybrids	Diameter/ear(mm)	Group	Ear with husk	Group	Ear without husk	Group
SF1379	49.56	b	4.100	ab	3.137	ab
Tyson	52.98	c	4.258	b	3.312	b
GSS6924	49.15	ab	3.979	a	3.058	a
Messenger	48.60	a	4.075	ab	3.13	ab
Hybrids	Length/ear(cm)	Group	Number kernels	Group	Yield kg (2-3 rows)	Group
SF1379	21.05	c	42.92	c	21.26	a
Tyson	18.63	a	36.84	a	25.75	a
GSS6924	20.01	b	36.85	a	25.75	a
Messenger	19.77	b	40.53	b	26.24	a
Hybrids	Moisture%	Group	Number/plants	Group	Plant height(cm)	Group
SF1379	73.10	b	63.089	a	130.3	a
Tyson	75.48	c	59.67	a	174.3	b
GSS6924	75.28	c	63.58	a	185.6	b
Messenger	62.72	a	77.58	b	174.3	b

- There are no statistical differences among the treatments having the same letter at the 0.05 level according to the Duncan test.

3.2 Analysis of variance on traits of Different Sowing dates of Four Hybrids of Sweet Corn, Season 2022

The combined variance analysis for the 2022 season showed that sowing dates significantly influenced key sweet corn traits, including emergence percentage, ear characteristics, yield, and plant height. The second sowing date provided the most favorable conditions, with an average yield of 17,138 kg/ha, while later sowing dates reduced yield by 1,299 kg/ha and 3,190 kg/ha, respectively. Significant differences among hybrids were observed (LSD%), with GSS6924 having the highest emergence percentage (92.66%) and Messenger achieving the highest yield (28.76 kg/ha). The results are presented in Table 3 and Figure 5. Correlation analysis (Tables 4 – 8) highlighted positive relationships between early emergence, vegetative growth, and yield, while delayed silking and high moisture content negatively impacted productivity. PCA biplot

analysis (Figure 6) clustered hybrids based on agronomic traits, showing strong correlations between yield, kernel traits, and plant growth. These findings emphasize the importance of optimizing sowing dates and selecting superior hybrids to maximize sweet corn yield under variable environmental conditions.

Table 3 Means of different sowing dates of different traits of sweet corn

Hybrids	Number/rows	Emergence%	Moisture%	Number/cobs	Number/plants	Plant height(cm)	Yield/kg
SF1379	17.68 a	68.32 a	74.43 a	61.17 a	59.25 a	147.7a	19.03 a
Braveheart	17.4 a	79.89 b	78.19 b	63.92 ab	61.50 ab	188.0b	22.82 b
Tyson	17.52 a	92.66 c	74.43 a	72.50 bc	72.42 c	206.6c	23.24 b
Messenger	17.28 a	84.74 b	77.32 b	76.25 c	69.75 bc	185.9 b	28.76 c

- Means followed by the same letters in each column are not significantly different according to DMRT at 5 levels of significance.

Table 4 Correlation coefficient between traits of Sweet Corn hybrids

Traits	Yield (kg/ha)	Emergence %	6 /Leaves stage	Silking%
Yield (kg/ha)	-	0.405**	0.208	-0.026
Emergence %	0.405**	-	0.687**	-0.118
6/ Leaves stage	0.208	0.687**	-	-0.011
Silking%	-0.026	-0.118	-0.011	-

*, ** indicate statistically significant differences between the characters at $P < 0.05$ and $P < 0.01$, respectively.

Table 5 Correlation coefficient among Traits of Sweet Corn hybrids

Traits	Number of Cobs	Moisture %	Time of Emergence	Tasselling%	Plant Height(cm)
Yield (kg/ha)	0.040	-0.451**	-0.329*	-0.030	-0.096
Emergence %	0.049	-0.494**	-0.329*	-0.116	0.505**
6/ Leaves stage	0.208	-0.451**	-0.011	-0.030	0.208
Silking%	0.218	-0.026	-0.490**	-0.493**	-0.065

*, ** indicate statistically significant differences between the characters at $P < 0.05$ and $P < 0.01$, respectively.

Table 6 Correlation coefficient between characters of Sweet Corn hybrids

Traits	Number of Plants(2-3 before harvest)	Length of Ear(cm)	Number of Rows	Diameter of Ear(mm)
Yield (kg/ha)	-0.055	0.049	0.005	0.105
Emergence %	0.653**	0.049	-0.022	0.286*
6/ Leaves stage	0.208	0.208	-0.022	0.066
Silking%	0.016	-0.035	0.469**	-0.471**

*, ** indicate statistically significant differences between the characters at $P < 0.05$ and $P < 0.01$, respectively.

Table 7 Correlation coefficient among traits of sweet corn hybrids

Traits	Number of Grains	Emergence %	6 /Leaves stage	Silking%	Number of Cobs
Number of Grains	-	-0.082	0.687**	-0.116	-0.113
Emergence %	-0.082	-	0.687**	-0.118	0.049
6/ Leaves stage	0.687**	0.687**	-	-0.011	0.208
Silking%	-0.116	-0.118	-0.011	-	0.218

*, ** indicate statistically significant differences between the characters at $P < 0.05$ and $P < 0.01$, respectively.

Table 8 Correlation coefficient of some traits of sweet corn hybrids

Traits	Moisture %	Time of Emergence	Tasselling%	Plant Height(cm)	Number of Plants(2-3 rows)	Length of Ear(cm)	Number of Rows	Diameter of Ear(mm)
Number of Grains	-0.494**	0.028	-0.142	-0.096	0.016	-0.041	-0.113	-0.113
Emergence %	-0.494**	-0.329*	-0.116	0.505**	0.653**	0.049	-0.022	0.286*
6/ Leaves stage	-0.451**	-0.011	-0.030	0.208	0.208	0.208	-0.022	0.066
Silking%	-0.026	-0.490**	-0.493**	-0.065	0.016	-0.035	0.469**	-0.471**

*, ** indicate statistically significant differences between the characters at $P < 0.05$ and $P < 0.01$, respectively.

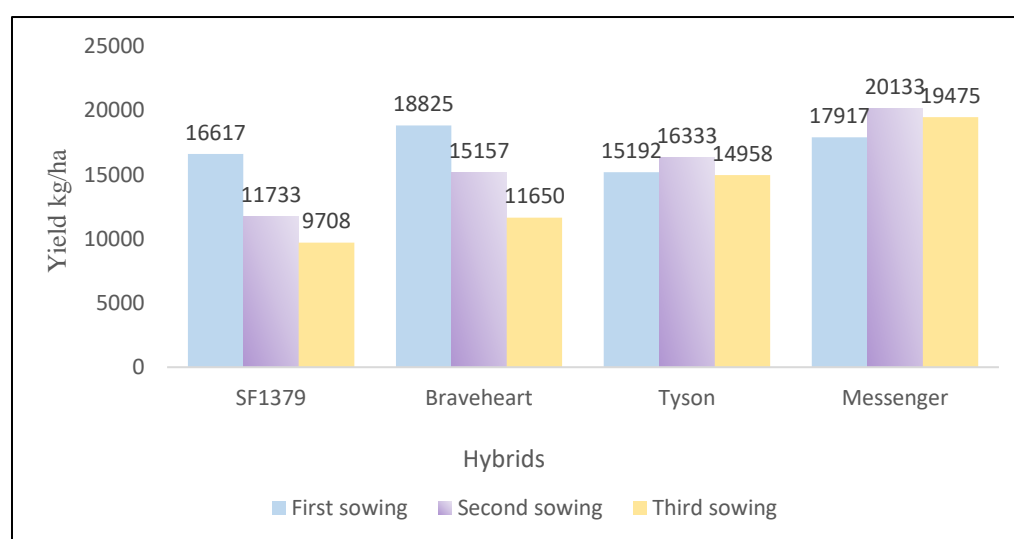


Figure 3 Messenger recorded the highest overall yields among the hybrids. In contrast, SF1379 and Braveheart produced comparatively lower yields in 2022.

3.3 Analysis of Variance of Different Levels of Nitrogen Fertilizer on Traits of Sweet Corn Hybrids (Season 2023)

The analysis of variance examined the impact of different nitrogen fertilizer levels on various traits of sweet corn hybrids. The study focused on flowering traits, emergence, cob weight, grain yield, and other agronomic parameters. The interaction between nitrogen levels and hybrid genotypes was also evaluated to determine their combined effect on sweet corn

performance. The experiment involved assessing multiple traits, including tasselling, silking, leaf development, and biomass accumulation, in response to varying nitrogen applications. Data were collected on both qualitative and quantitative traits, with a focus on understanding how nitrogen influences growth stages, efficiency, and overall productivity.

The statistical analysis was conducted to evaluate differences among hybrids, nitrogen levels, and their interactions. The primary aim was to determine whether nitrogen application significantly influenced agronomic traits and whether genotype-specific responses were observed. Previous research has indicated that nitrogen plays a crucial role in plant development, influencing both vegetative and reproductive phases.

Additionally, past studies have shown that nitrogen affects flowering synchrony and cob formation, impacting yield outcomes. The current study aligns with existing literature, highlighting nitrogen's role in optimizing plant growth. The results are presented in Figure 7.

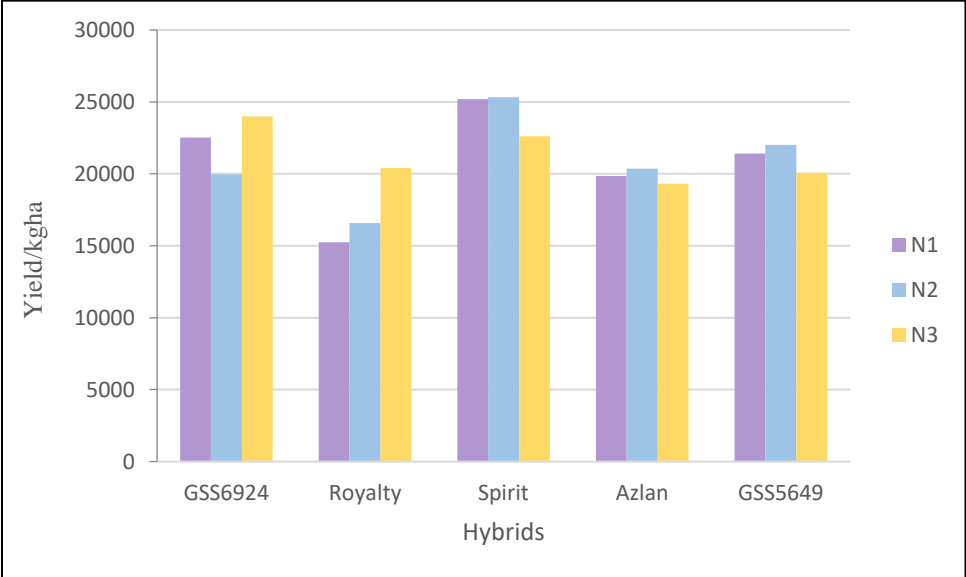


Figure 4 Effect of different levels of Nitrogen Fertilizer on the Yield kg/ha of Five Sweet Corn Hybrids, Season 2023

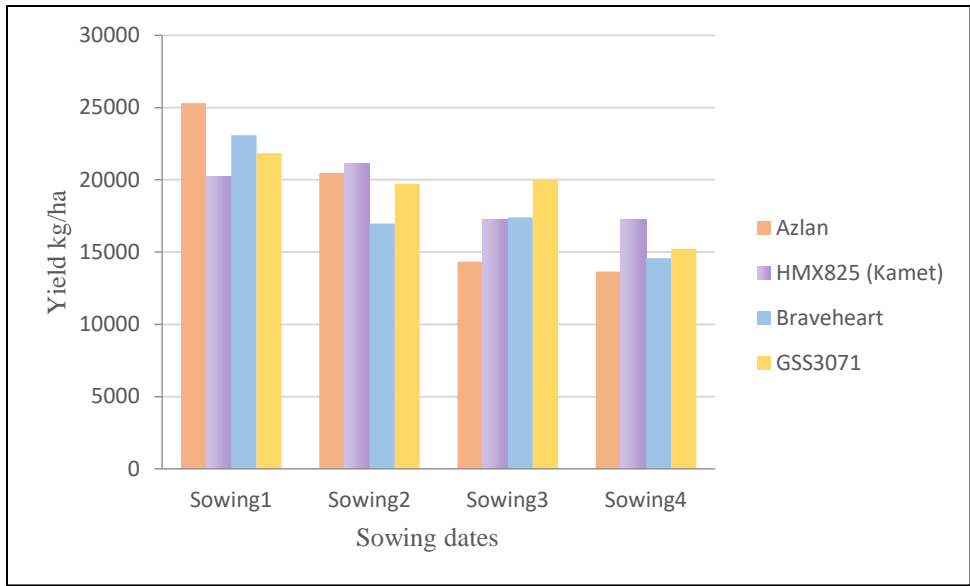


Figure 5 Effect of varying sowing dates on the yield kg/ha of sweet corn hybrids, season 2023

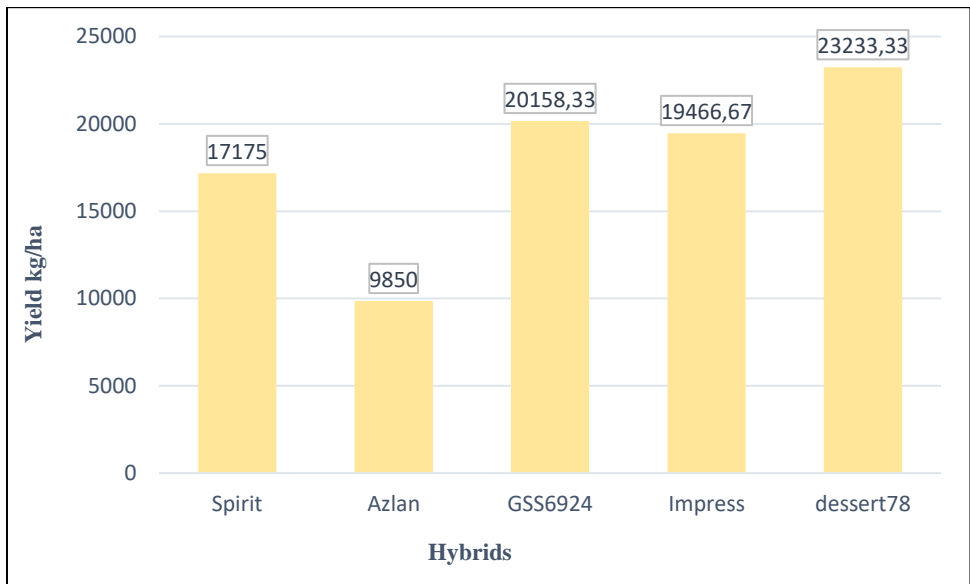


Figure 6 Potential Yield kg/ha between Five Sweet Corn Hybrids, Season 2023

3.4 Analysis of Variance of Different Sowing Dates on Traits of Sweet Corn Hybrids (Season 2023)

The combined analysis of variance revealed that sowing dates had a significant impact on most traits of sweet corn hybrids. The interaction between sowing dates and genotypes also showed highly significant differences for several traits, while a few remained unaffected. The results highlighted that early sowing dates led to better crop performance and yield outcomes. Previous research supports these findings, indicating that sowing dates influence maize phenology, growth, and yield. Studies have demonstrated that early sowing generally enhances growth parameters and yield, whereas delayed sowing can negatively affect plant development due to

shorter growing periods and exposure to unfavourable environmental conditions. Additionally, different maize genotypes exhibit varied responses to sowing dates, underscoring the importance of selecting optimal hybrids for specific planting conditions.

This study further aligns with previous research that emphasizes the critical role of sowing dates in maximizing crop productivity. The results of this experiment provide valuable insights for optimizing planting schedules to improve sweet corn yield and efficiency.

Tables and figures present detailed statistical analyses of the traits studied across different sowing dates. The results are presented in Figure 8.

3.5 Analysis of Variance for Estimation of Yield Potential in Sweet Corn Hybrids (Season 2023)

The analysis of variance for yield potential in sweet corn hybrids indicated no significant differences for most traits, except for grain yield, number of seeds, number of rows, and cob weight (with and without leaves). Among the hybrids, Dessert 78 recorded the highest yield (23,233.33 kg/ha), while Azlan had the lowest (9,850 kg/ha).

The study also examined variations in plant height, emergence percentage, dry matter, dry weight, fresh weight, and efficiency among hybrids. GSS6924 showed the greatest plant height, whereas Spirit had the lowest. Azlan and GSS6924 exhibited the highest emergence percentage, while Dessert 78 recorded the lowest. Spirit had the highest dry matter and dry weight, while Impress and Dessert 78 had the lowest. In terms of fresh weight, Dessert 78 outperformed other hybrids, while Azlan recorded the smallest value. Efficiency was highest in Azlan and Impress but lowest in GSS6924. Previous studies confirm that maize hybrid performance is influenced by genetic traits and environmental factors. Research has shown that hybrids with superior agronomic traits tend to have higher yields, especially when well-adapted to environmental conditions. Factors such as soil quality, temperature, and rainfall play a significant role in determining hybrid performance. Selecting hybrids with both strong genetic potential and environmental adaptability is crucial for maximizing yield. The results are presented in Figure 9.

3.6 Analysis of variance of the Effect of Different Plant Densities on traits of Four Sweet corn hybrids, Season 2022

The analysis of variance for sweet corn hybrids in 2022 highlighted significant differences in traits such as emergence percentage, number of cobs, plant height, ear diameter, number of kernels, and rows. However, moisture content and ear with husk showed only significant

differences between hybrids. The study concluded that sweet corn hybrids can be successfully grown with a lower plant density of 60,000 plants per hectare, with a yield decrease observed at higher plant densities (70,000 and 80,000 plants per hectare). These findings were consistent with previous research, which indicated that high plant densities might reduce yield by limiting space for optimal ear growth, though some hybrids showed improved marketable ear mass at higher densities. The results as presented in Figure 10.

Additionally, the results agreed with studies that showed an optimal density for sweet corn hybrids to avoid crowding stress, though excessively high densities can result in reduced ear size and kernel numbers. Correlation analysis revealed significant positive relationships between traits such as plant height and ear diameter, as well as emergence percentage and the number of kernels. The regression analysis supported the finding that the number of cobs and kernels was closely linked to yield, suggesting that optimizing these traits can enhance overall productivity.

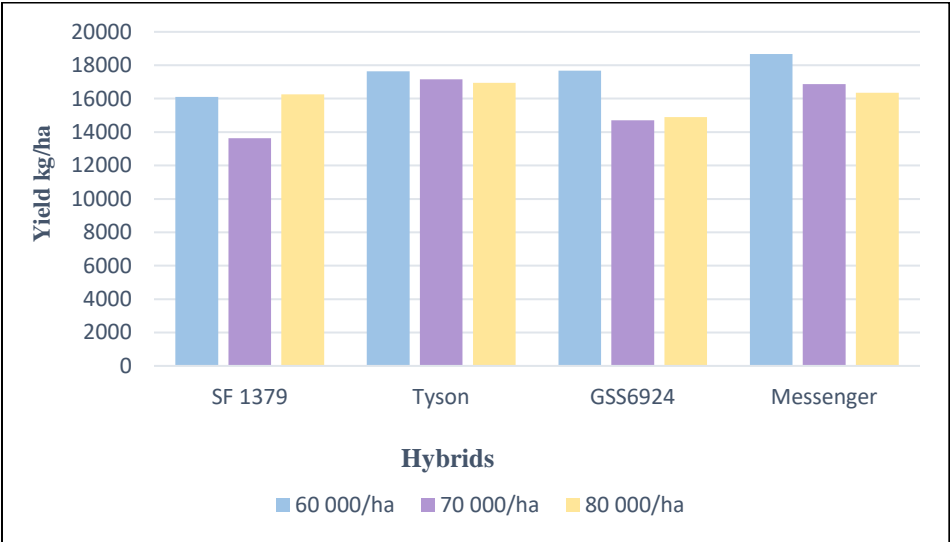


Figure 7 Effect of different plant densities on yield/kg /ha of four sweet corn hybrids, 2022

3.7 Performance Evaluation of Sweet Corn Hybrids Braveheart and GSS6924 (2022–2023)

The studies focused on the analysis of variance (ANOVA) and LSD% for several traits and parameters of different sweet corn hybrids (Braveheart and GSS6924) over two seasons (2022 and 2023) to evaluate the impact of varying sowing dates and nitrogen fertilizer levels on plant growth, yield, and other agronomic traits.

For Braveheart Hybrid (2022), ANOVA indicated highly significant differences in several traits, including emergence percentage, moisture content, and number of rows. Significant

differences were also observed for ear and plant characteristics such as grain yield, number of plants before harvest, and ear length. However, plant height and ear diameter showed no significant differences across sowing dates. Similarly, Braveheart Hybrid (2023) showed highly significant effects on traits like 50% silking, 50% tasselling, and emergence percentage. Significant variations were also found for ear and cob traits, including yield, weight, and the number of rows per cob, but efficiency showed no significant difference. The results are presented in Figure 11.

For GSS6924 Hybrid (2022), ANOVA revealed highly significant effects of sowing dates on emergence percentage, while significant differences were found for plant height, cob number, moisture content, and number of rows. There were no significant differences in grain yield or other traits like ear length and lodged plants. In GSS6924 Hybrid (2023), significant differences were found in traits such as leaf count, nitrogen efficiency, seed number, and total cob weight. The analysis also revealed no significant variation in some yield parameters, like grain yield and emergence percentage.

The LSD% analyses for GSS6924 Hybrid (2022) and Braveheart Hybrid (2022 and 2023) provided additional insights into the effects of different nitrogen levels and sowing dates on yield and plant traits. The results showed that certain nitrogen levels positively influenced grain yield, ear length, and plant height, while others resulted in variations in moisture content, plant density, and lodging. For example, in the 2022 season, nitrogen application showed a slight increase in yield and ear length, with 2N and 3N showing the highest grain yields. Similarly, Braveheart Hybrid (2023) displayed notable differences in plant height and yield across sowing dates, with the first sowing date generally outperforming others in several parameters.

This research provides valuable insights into optimizing sowing dates and nitrogen fertilizer levels for improved sweet corn production, particularly for traits influencing overall yield and quality. The study also incorporated factor analysis, which identified key factors influencing yield, with factors such as the six-leaf stage, time to silking, and time to tasselling being closely associated with yield. The analysis demonstrated that the right combination of plant density and hybrid choice could significantly affect the yield, with environmental factors also playing a crucial role. Overall, these findings provide valuable insights for optimizing sweet corn production, emphasizing the importance of balancing plant density with hybrid characteristics to achieve the best yield outcomes.

The correlation analysis of the Braveheart hybrid (2022) and the GSS6924 hybrid (2022) highlighted significant relationships between various traits contributing to grain yield. In

Braveheart, high positive correlations were observed between emergence percentage and leaf stages, silking time and tasselling time, as well as ear characteristics such as ear weight and grain yield. GSS6924 demonstrated strong correlations between cob length, kernel count, and grain yield. These findings suggest the importance of selecting traits that are strongly correlated with yield for improved breeding strategies. The cluster analysis of both hybrids showed distinct groupings based on morphological traits, with the Braveheart hybrid demonstrating variability in ear diameter and yield across different clusters. The GSS6924 hybrid also exhibited similar patterns, with cluster analysis revealing variations in traits such as ear characteristics and yield, and higher genetic distances indicating potential for greater heterosis in breeding programs.

In terms of performance comparison across seasons, the Braveheart hybrid displayed consistent benefits from early sowing in both 2022 and 2023, showing higher yields and better plant growth with early planting. GSS6924 hybrid, on the other hand, was less influenced by nitrogen levels in 2022, with yield being more dependent on the sowing date. However, in 2023, nitrogen did show slight positive effects on yield, albeit with minimal impact on overall productivity.

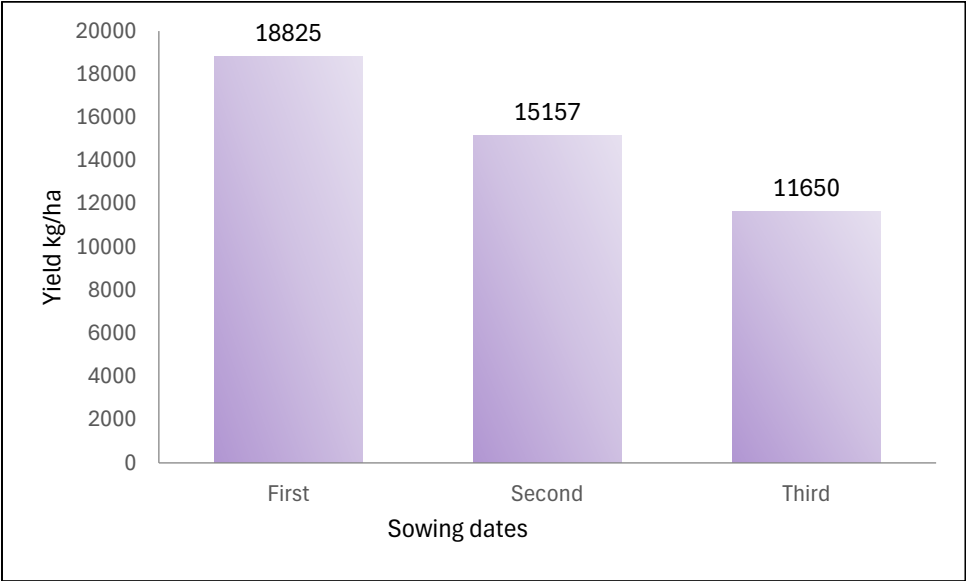


Figure 8 Influence of different sowing dates on the yield kg/ha of Braveheart hybrid season 2022

3.8 Estimation of 32 sweet corn hybrids on traits of various sowing dates, season 2023

The study evaluating the performance of 32 sweet corn hybrids across two sowing dates in the 2023 season yielded several key findings. On the first sowing date, the highest plant height was recorded by HMC305 at 242 cm, while on the second sowing date, Impress exhibited the tallest plants at 251 cm. In terms of yield, HMC302 produced the highest yield of 29,300 kg/ha on the first sowing date, while Messenger achieved the highest yield of 22,300 kg/ha on the second sowing date. Regarding dry matter per cob, the first sowing date produced the highest value,

scoring 31.54 g/cob, while Royalty recorded 34.99 g/cob on the second sowing date. The number of cobs per plot was higher on the second sowing date, with SVSK4540 recording 89, compared to HMC302's 114 on the first sowing date. The number of seeds per cob was highest on the first sowing date with ZHY5022OD at 43.4, while ZHY5233OD reached 43.7 on the second sowing date.

For grain yield, ZHY5022OD achieved the highest yield on the first sowing date, whereas SVSK2949 topped the second sowing date with a yield of 2.02. The ear length was longest on the first sowing date for ZHY5022OD at 22.6 cm, while ZHY5233OD had a slightly longer ear length of 23.15 cm on the second sowing date. The number of rows per cob was highest on the first sowing date for 1446 (20.2), and HMX832 and Messenger each recorded 19 rows on the second sowing date. These results align with previous studies on maize hybrids, where plant height, dry matter per cob, ear length, and rows per cob varied between sowing dates. The findings highlight the importance of sowing date on hybrid performance and underscore the potential for genetic improvement in sweet corn through breeding programs focused on diverse germplasm sources and heterotic groups.

4. NEW SCIENTIFIC RESULTS

The new scientific findings of this study include:

-Nitrogen fertilization was optimal at 100 kg N ha⁻¹, while higher rates (150–200 kg N ha⁻¹) reduced yield efficiency.

-A plant density of 60,000 plants ha⁻¹ ensured successful crop establishment and high yield performance.

-Early sowing enhanced crop development and yield, with HMC302, Messenger, Spirit, and Azlan showing superior performance and clear hybrid × sowing date interactions.

-Early flowering and adaptability were observed in GSS6924, GSS649, Azlan, Braveheart, and GSS3071, which reached tasselling and silking earlier and supported efficient cropping cycles, while Messenger demonstrated high adaptability under varying management conditions.

5. PRACTICAL UTILIZATION OF RESULTS

- Optimized agronomic practices should be applied, including early sowing (usually mid-April in Hungary) to extend the growing season, enhance crop development, and improve yield and harvest period.

-A planting density of 60,000 plants ha⁻¹ and 100 kg N ha⁻¹ of nitrogen fertilizer applied in split doses at planting and early growth stages ensures healthy growth, efficient nutrient use, and soil health.

-High-performing hybrids such as Messenger provide maximum yield and quality, while early flowering varieties like GSS6924, GSS649, and Azlan allow for early harvest, and Spirit and HMC305 increase overall productivity and maintain consistent quality.

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7.LIST PUBLICATION



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Subject: PhD Publication List

Candidate: Hajer Mohamed Ibrahim Sidahmed
Doctoral School: Kálmán Kerpely Doctoral School
MTMT ID: 10099651

List of publications related to the dissertation

Hungarian scientific articles in Hungarian journals (3)

1. Bakos, Z., **Sidahmed, H. M. I.**, Nagy, J.: A Honey csemegekukorica (*Zea mays L. convar. saccharata* Koern) hibrid ásványianyag-, foszfor-, kálium-, magnézium-, cink- és vastartalmának elemzése.
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13. Ocwa, A., Acaye, F., Abakeer, R. A., Ahmed, A. E. M., **Sidahmed, H. M. I.**, Harsányi, E.:
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14. Mousavi, S. M. N., Illés, Á., Bojtor, C., Demeter, C., Bakos, Z., Vad, A., Abakeer, R. A.,
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In: Plant science and agriculture Hybrid Event : Book of abstract, Magnus Group LLC, Valencia, 117, 2023.

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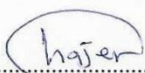
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11. DECLARATION

I prepared this dissertation within the framework of Kálmán Kerpely doctoral school of the University of Debrecen, in order to obtain a doctoral (PhD) degree from the University of Debrecen.

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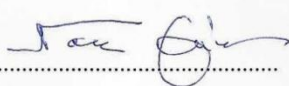

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DECLARATION

I certify that name; a doctoral candidate between (2021-2025) and within the framework of the above-mentioned doctoral school, has carried out his work under my guidance/direction. The independent contribution of the candidate to the results included in the dissertation, the dissertation is the independent work of the candidate. I suggest/recommend the acceptance of the dissertation.

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