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Research Article

Investigation of Some Agronomic Performances of Local Maize Populations with Different Kernel Colors and Kernel Structures

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Abstract

Maize is a crop with broad usage globally and is significant in various areas. From an agronomic perspective, it is known for its diversity in both quality traits and adaptation to different conditions. Particularly, there is notable variation in maize genotypes regarding color-related traits and anthocyanin compounds, which have been the focus of recent studies. Commercial maize varieties are widely grown, but efforts to develop new varieties with superior agronomic and nutritional traits are ongoing. Rich in genetic variation, colored maize genotypes are characterized by their high phenolic content and antioxidant activity, which are essential in terms of nutritional and health benefits.

This study was conducted to determine the agronomic characteristics of 14 local maize genotypes with varying grain colors and 2 standard varieties under Çanakkale conditions during the main summer cropping seasons of 2021 and 2022, using a randomized block design with three replications. In the study, traits such as days to flowering, plant height, first ear height, ear length, ear diameter, ear weight, kernel weight per ear, and the number of kernels per ear were examined. Significant variation was observed among the local maize genotypes for the traits examined. The days to flowering ranged from 54.9 to 70.0 days, plant height from 114.61 to 230.8 cm, first ear height from 40.8 to 110.8 cm, ear length from 12.9 to 17.7 cm, ear diameter from 29.1 mm to 37.7 mm, ear weight from 59.8 to 109.4 g, kernel weight per ear from 46.3 to 93.7 g, and the number of kernels per ear ranged from 324.5 to 611.4. The local maize genotypes coded as POP3, POP4, POP14, POP5, POP7, and POP9 were found to be promising in terms of kernel weight per ear and plant height traits. These materials are considered potential genetic resources for future breeding programs, especially when evaluated for grain quality and color characteristics.

Keywords: *Zea mays*, colored maize, local genotype, plant traits.

Farklı Tane Renklerine ve Tane Yapılarına Sahip Yerel Mısır Popülasyonlarının Bazı Agronomik Performanslarının İncelenmesi

Öz

Mısır küresel düzeyde birçok alanda kullanılan önemli bir tahıldır. Hem agronomik hem de kalite özellikleri bakımından geniş bir varyasyona sahip olan mısırda tane rengi bakımından da dikkate değer bir çeşitlilik bulunmaktadır. Renkle ilişkilendirilen antosiyanin ve fenolik bileşiklere olan ilgi renkli mısır genotiplerine de olan ilgiyi artırmıştır. Ticari mısır çeşitleri genel olarak verimi hedefleyen ıslah çalışmalarıyla geliştirildiğinden tane rengi bakımından mısırdaki genetik varyasyon oldukça daralmıştır. Son yıllarda antosiyanin ve fenolik bileşiklerce zengin mısır genotiplerinin doğal gıda boyası başta olmak üzere yüksek antioksidan içerikleriyle tamamlayıcı ve destekleyici tıbbi uygulamalarda kullanımlarının artması renkli mısırlara olan ilgiyi artırmıştır.

Bu çalışma tane rengi yönünden farklılık gösteren 14 adet yerel mısır genotipi ve 2 standart çeşidin Çanakkale koşullarındaki agronomik özelliklerini belirlenmesi amacıyla 2021 ve 2022 yılları yazlık ana ürün sezonunda tesadüf blokları deneme planına göre 3 tekerrürlü olarak yürütülmüştür. Çalışmada çiçeklenme gün sayısı, bitki boyu, ilk koçan yüksekliği, koçan uzunluğu, koçan çapı, koçan ağırlığı koçanda tane ağırlığı ve koçanda tane sayısı özellikleri incelenmiştir. İncelenen özellikler bakımından yerel mısır genotiplerinde dikkate değer bir varyasyon olduğu belirlenmiş olup, çiçeklenme gün sayısı 54,9-70,0 gün, bitki boyu 114,61-230,8 cm, ilk koçan yüksekliği 40,8-110,8 cm, koçan uzunluğu 12,9-17,7 cm, koçan çapı 29,1 mm-37,7 mm, koçan ağırlığı 59,8-109,4 gr, koçanda tane ağırlığı 46,3-93,7 gr ve koçanda tane sayısı 324,5-611,4 adet arasında değişim göstermiştir. Kullanılan yerel mısır genotiplerinden POP3, POP4, POP14, POP5, POP7 ve POP9 kodlu

popülasyonların koçanda tane ağırlığı ve bitki boyu özellikleri bakımından ümitvar olduğu görülmüştür. Bu materyallerin tane kalitesi ve renk özellikleri bakımından da değerlendirilerek ileride yürütülecek ıslah çalışmalarında kaynak materyal olarak kullanılabileceği değerlendirilmiştir.
Anahtar Kelimeler: Mısır, renkli mısır, yerel genotip, bitkisel özellikler.

Introduction

Maize, a member of the Poaceae family, is an annual cereal crop adapted to warm climates. Among cereals, it is notable for having the highest yield per unit area and is one of the most widely cultivated crops widely and in Turkey (Kırtok, 1998). Due to its high starch content (68–75%), maize is mainly used in animal feed both worldwide and in Turkey. On the other hand, maize contains significant amounts of oil (3-5%) and protein (8-11%) in its kernels, making it a valuable resource for human nutrition and an essential raw material in the production of various food products in the industrial sector (Taş et al., 2011).

Grain color in maize is a highly variable trait, with genotypes exhibiting a wide range of colors from white to black. However, in most countries, the majority of commercially registered varieties consist of yellow or orange-colored genotypes. Genotypes with red, purple, or black kernels, which fall outside this range, are referred to in the literature as “colored corn”. Colored maize genotypes are among the rare cereals with high genetic diversity, containing carotenoids, anthocyanins, phlobaphenes, and phenolic compounds known for their positive effects on human health. These compounds that give color to maize have been proven to benefit human and animal health due to their high antioxidant capacity. Purple maize genotypes are particularly rich in anthocyanins, which are abundantly found in their kernels, tassels, cob husks, leaves, and stems (Paulsmeyer and Juvik, 2023). The colored maize can be used as natural food colorants, serving as an alternative to synthetic dyes due to their coloring properties. Moreover, these pigments, which are abundant in colored maize genotypes, have been reported to offer several health benefits. Studies have highlighted their positive effects on cardiovascular health, their role in improving insulin resistance, their ability to delay premature aging, and their anti-cancer properties (Zhu, 2018; Colombo et al., 2021). Studies have shown that colored maize genotypes when used as forage in animal feed, produce silage that does not negatively impact milk composition. Additionally, silage derived from colored maize has been found to possess high superoxide dismutase concentrations, improve milk yield, and positively influence silage fermentation (Tian et al., 2018; Matsuba et al., 2019). Generally, colored maize genotypes are genetic resources predominantly maintained by traditional farmers, as they are typically local populations rather than commercially produced varieties.

Significant progress has been made in studies focused on areas such as genetic resource characterization, molecular research, and the identification of potential applications of local maize populations. The positive outcomes of these studies are primarily based on the high genetic diversity inherent in maize (Kahrıman et al., 2020). The preservation and transmission of the genetic diversity found in local maize genotypes to future generations are crucial for national food security. The priority in this regard is the conservation and characterization of genetic resources, with local village populations, which exhibit high adaptability to the climate and environmental factors of their cultivation regions, being key resources in this context. From a national perspective, there are significant benefits in characterizing local maize genotypes and incorporating these genotypes into breeding programs. To this end, studies have been conducted in our country to identify genotypes with high grain and silage yields (Öner, 2017), examine their agronomic performance (Öztürk and Büyükgöz, 2021; İdikut et al., 2020; Kahrıman et al., 2019), and characterize them using molecular techniques (Akbulut et al., 2021; Cömertpay, 2011). However, research on the vegetative traits of colored local maize populations in our country has been very limited.

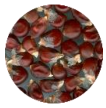
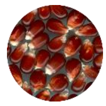
This study aimed to determine the vegetative performance of 14 colored local maize genotypes collected or obtained from different regions of Turkey and to assess their agronomic performance in comparison to two standard varieties. Based on the findings obtained from the research, the goal was to identify genotypes within the colored local village populations that can be used as source materials for different purposes.

Materials and Methods

Plant Material and Experiment Implementation

A total of 16 different genotypes, including 14 pigmented genotypes and 2 standard hybrid varieties, were used as materials in this study. The genotypes exhibit the characteristics of dent corn, flint corn, and popcorn in terms of seed traits and generally feature purple, red, orange, yellow, and white colors (Table 1). These genotypes were previously obtained from various regions of Turkey for scientific research purposes by the Department of Field Crops at the Faculty of Agriculture, Çanakkale Onsekiz Mart University.

Table 1. Genotypes and their characteristics used in the study.

Code	Collection Site	Seed Color		Code	Collection Site	Seed Color	İmege/Kernel Structure
POP1	Trabzon	Red	*Zea Mays everta* 	**POP9**	Çanakkale	Purple	*Zea Mays indurata* 
POP2	Tokat	Red	*Zea Mays indurata* 	**POP10**	Tokat	Light Purple	*Zea Mays everta* 
POP3	Artvin	Red	*Zea Mays indurata* 	**POP11**	Sakarya	Light Purple	*Zea Mays everta* 
POP4	Rize	Red	*Zea Mays everta* 	**POP12**	Ağrı	White	*Zea Mays indurata* 
POP5	Ordu	Purple	*Zea Mays indurata* 	**POP13**	Çanakkale	White	*Zea Mays everta* 
POP6	Gaziantep	Purple	*Zea Mays everta* 	**POP14**	Aydın	Red	*Zea Mays everta* 
POP7	Trabzon	Purple	*Zea Mays everta* 	**Standard 1**	Commercial Variety	Yellow/ Orange	*Zea Mays indentata* 
POP8	Trabzon	Purple	*Zea Mays indurata* 	**Standard 2**	Commercial Variety	Yellow/ Orange	*Zea Mays indentata* 

Climate and Soil Characteristics

According to climate data obtained from the Turkish State Meteorological Service, the long-term average temperature in Çanakkale is recorded as 15.09°C. The average temperatures for the years in which the experiment was conducted for two years, 2021 and 2022, were 17.5°C and 16.2°C, respectively, both higher than the long-term average. During the six-month experimental period (May–October), the average temperature for 2021 and 2022 was recorded as 23.05°C. The long-term total precipitation during the same six-month period (May-October) is 149.9 mm. In the first year of the study, total precipitation during this period was 201.2 mm, while in the second year, it was 173.2 mm (Figure 1).

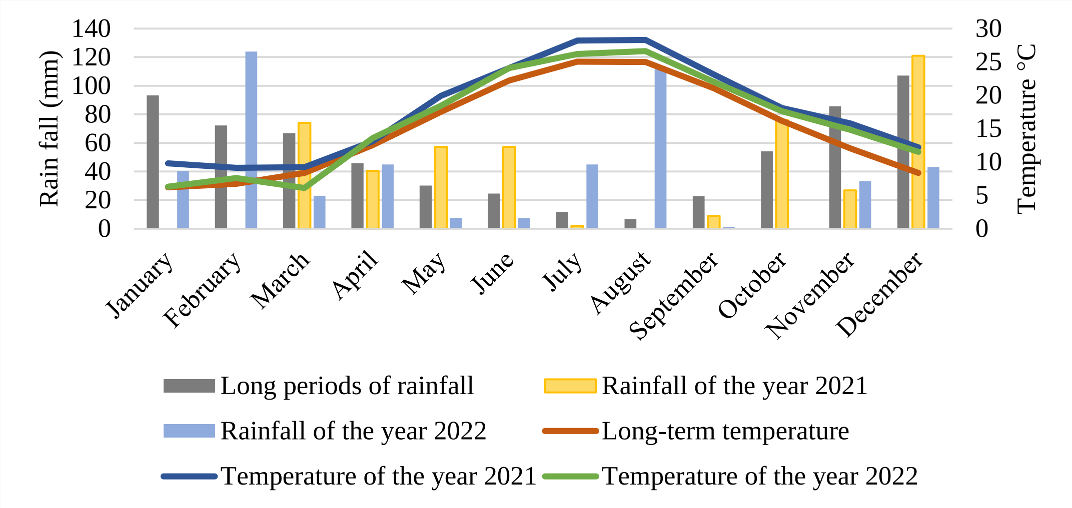


Figure 1. Climate data for Çanakkale's experiment years and long-term.

Table 2. Soil properties of the study.

Field Capacity (%)	pH	E.C. (mS/cm)	—	Lime Content (%)	Organic Matter (%)	P (kg/da)	K (kg/da)
66.5	7.33	0.91		8.4	1.86	2.77	81.02
Clay-loam	Neutral	Salt-free		Moderately calcareous	Low	Low	Low

Field Experiments and Evaluated Characteristics

The field experiment was conducted in the summer seasons of 2021 and 2022 in Çanakkale under a randomized block design with three replications. The experiment was established on May 10, 2021, in the first year, and on May 18, 2022, in the second year. In both years of the experiment, fertilization was applied with a dose of 24 kg/da of pure nitrogen. Irrigation was carried out using a drip irrigation system, and weed control was performed mechanically. Harvesting was done manually after the plants reached physiological maturity. In addition to the controlled pollination processes, at least five cobs in each plot were left open for natural pollination.

The plant characteristics examined were observed according to the Maize Technical Instructions of the Seed Certification and Registration Center (TTSM, 2018). Measurements of plant height and first ear height were taken from 10 randomly selected plants in each plot. Measurements for ear weight, ear length, ear diameter, seed weight per ear, and seed count per ear were conducted on five randomly selected ears left for natural pollination in each plot. Flowering observations were made on a row basis.

Table 3. Abbreviations of the investigated traits and their measurement methods.

Examined Characteristics	Methods for Determining the Characteristics
Plant Height	The distance from the soil surface to the tip of the plant's tassel was measured in centimeters (cm).
First Ear Height	The distance from the soil surface to the node where the first ear is attached was measured in centimeters (cm).
Flowering Days	The number of days from planting until the day when the tassel is visible on half of the plants in a row.
Ear Length	The distance from the base to the tip of the ear was measured in centimeters (cm).
Ear Diameter	The diameter of the middle section of the ear was measured with a caliper in millimeters (mm).
Ear Weight	The weight of the ear, including the cob, was determined using a precision scale (g).
Seed Weight per Ear	The weight of the seeds obtained from the ear sample was measured in grams (g) using a precision scale
Seed Count per Ear	The number of seeds on the ear was counted manually.

Statistical Analyses

The data obtained in the study were analysed using the SAS statistical software based on the Randomized Block Design (SAS Institute, 1999). Differences between means were determined using the Least Significant Difference (LSD-5%) test.

Rersults and Discussion

According to the analysis of variance results for the observed characteristics, significant differences were found between the varieties in all years and combined analyses. The effect of years on the observed characteristics showed statistically significant changes in first ear height and seed count per ear. The year × variety interaction was found to be statistically significant for all characteristics except for the flowering days.

Flowering Days (days): When examining the flowering days of the genotypes, the lowest number of flowering days in both 2021 and 2022 was observed in the POP2 genotype. In 2021, the genotype with the highest flowering days was POP11 with 73 days, while in 2022, POP13 had the highest flowering days with an average of 70.7 days. The average flowering days of the local genotypes ranged from 54.9 days to 70.0 days (Table 4). In another study using local corn genotypes, similar results to our findings were reported, with flowering days ranging from 57.6 to 77.7 days (Kahrıman et al., 2019). Flowering days are an important criterion, particularly in the breeding of early and late varieties. The early-flowering local genotype, POP2, can be used as a source material in breeding programs aimed at developing early-maturing varieties.

Plant Height (cm): When examined the average plant heights of the genotypes, the highest plant height in the first year was observed in the Standard1 genotype with 246.6 cm, while the lowest plant height was found in the early-flowering POP2 genotype with 163.9 cm. In the second year, the highest plant height was recorded in the POP14 genotype. As in the first year, the lowest plant height in the second year was also recorded in the POP2 genotype (Table 4).

Table 4. Average values for plant height and first ear height according to years and populations.

	Flowering Days (days):			Plant Height (cm):		
Populations	**2021**	**2022**	**Average**	**2021**	**2022**	**Average**
Pop1	61.0 f	63.8 cde	62.4 f	181.7 h	169.8 d	175.8 h
Pop2	56.2 g	53.7 f	54.9 g	163.9 i	125.3 e	144.6 i
Pop3	64.5 cd	64.8 b-e	64.6 ef	241.5 ab	180.9 bcd	211.2 bcd
Pop4	63.0 de	62.9 de	62.9 f	233.4 ab	203.4 ab	218.4 ab
Pop5	64.2cd	70.5 a	67.3 cd	206.2 def	180.8 bcd	193.5 efg
Pop6	62.2 ef	64.1 b-e	63.1 f	192.7 fgh	178.7 cd	185.7 fgh
Pop7	67.7 b	64.9 b-e	66.3 cde	216.2 cd	188.8 bcd	202.5 cde
Pop8	69.0 b	67.4 abc	68.2 bc	211.4 cde	183.7 bcd	197.6 de
Pop9	65.5 c	65.8 b-e	65.6 de	198.8 efg	183.7 bcd	191.2 efg
Pop10	67.5 b	66.8 a-d	67.1 cd	189.5 gh	178.8 cd	184.2 fh
Pop11	73.0 a	67.1 abc	70.0 ab	186.0 gh	179.9 bcd	183.0 fh
Pop12	67.7 b	66.9 abc	67.3 cd	190.4 fgh	190.1 bcd	190.2 egh
Pop13	69.0 b	70.7 a	69.9 ab	187.5 gh	174.7 d	181.1 gh
Pop14	65.0 c	68.0 ab	66.5 cde	241.3 ab	220.4 a	230.8 a
Standard1	71.7 a	70.5 a	71.1 a	246.6 a	214.5 a	230.5 a
Standard2	62.2 ef	62.5 e	62.3 f	227.4 bc	200.0 abc	213.7 bc
Average	**65.6**	**65.6**	**65.6**	**207.1 A**	**184.6 B**	**195.9**

Notably, the average plant heights of the POP3, POP4, and POP14 genotypes were close to or higher than those of the hybrid varieties. In a study conducted by Öztürk et al. with 18 local genotypes, the plant height results were similar to our findings, ranging from 166.3 cm to 293.9 cm. Other studies using local genotypes as materials have also reported similar results (Rahmawati et al., 2023; Rabanal-Atalaya et al., 2021). In corn, a taller plant height positively affects single-plant yield, which is particularly desirable in silage corn production (Ünsal, 2020). It has been considered that these coloured local genotypes could be used as source material in future studies for developing silage varieties.

First Ear Height (cm): The general average first ear height of the genotypes ranged from 40.8 cm to 110.8 cm. In both the first and second years, the lowest first ear height was recorded in the POP2 genotype. In the first year, the highest first ear height was observed in the POP3 genotype with 113.1 cm, while in the second year, the highest value was recorded in the POP14 genotype with an average of 110.1 cm. Among the local genotypes, POP3 and POP14 had the highest first ear height averages, while in the standard varieties, Standard1 had the highest average first ear height (Table 5). In a study conducted in Ordu province using local genotypes as material, the first ear heights were found to be in a broader range, from 12 cm to 195 cm, which is wider than the range observed in our study (Öner, 2017).

Ear Length (cm): In the first year, the genotypes POP2, Standard1, and Standard2 produced the highest ear length results, while the lowest ear length was observed in the POP12 genotype. In the second year, the highest average ear lengths were recorded in the following genotypes: POP8 (20.0 cm), POP3 (19.6 cm), and POP4 (18.4 cm), with the lowest value again observed in the POP12 genotype (12.9 cm), as in the first year (Table 5). In a study by İdikut et al. (2015), they found the ear length of local flint corn varieties to be in the range of 12.92 cm to 17.50 cm, which is consistent with our results. Since ear length directly affects plant yield, a high ear length is desired during the variety development stages.

Table 5. Average values of flowering days and cob length according to years and populations.

	First Ear Height (cm)			Ear Length (cm)		
Populations	**2021**	**2022**	**Average**	**2021**	**2022**	**Average**
Pop1	82.5 def	57.3 d	69.9h	15.8 b-e	15.1 c-f	15.5 cde
Pop2	48.2 g	33.4 e	40.8 i	17.1 abc	15.8 b-f	16.4 a-d
Pop3	113.1 a	82.3 bc	97.7 b	15.7 b-e	19.6 a	17.7 abc
Pop4	105.4 ab	88.8 b	97.1 bc	16.7 a-d	18.4 ab	17.6 abc
Pop5	93.0 bcd	77.7 bc	85.4 ce	12.7 fg	16.0 b-e	14.4 def
Pop6	77.5 def	74.4 bc	76.0 fh	14.0 d-g	14.7 c-f	14.3 def
Pop7	99.8 abc	90.1 b	95.0 bd	14.7 c-f	17.5 abc	16.1 bcd
Pop8	104.5 ab	81.3 bc	93.0 be	15.1 c-f	20.0 a	17.6 abc
Pop9	75.3 ef	71.6 cd	73.4 gh	15.8 b-e	16.0 b-f	15.9 b-d
Pop10	80.9 def	78.3 bc	79.6fh	14.5 c-g	14.8 c-f	14.7 def
Pop11	88.2 cde	81.0 bc	84.6 dg	11.6 g	14.1 ef	12.9 f
Pop12	70.1 f	70.3 cd	70.2 h	13.5 e-g	12.9 f	13.2 f
Pop13	85.0 c-f	80.2 bc	82.6 eg	12.4 fg	14.3 def	13.4 ef
Pop14	111.5 a	110.1 a	110.8 a	15.7 b-e	15.2 c-f	15.5 cde
Standard1	108.9 ab	88.9 b	98.9 b	18.5 ab	17.3 a-d	17.9 ab
Standard2	88.3 cde	67.7 cd	78.0 fh	19.4 a	17.7 abc	18.6 a
Average	**89.5 A**	**77.1 B**	**83.33**	**15.2 B**	**16.2 A**	**15.7**

Ear Diameter (mm): When examining the ear diameter data for the first year, the genotype with the highest ear diameter was Standard1 (49.9 mm). Among the local populations, POP9 had the highest ear diameter at 37.8 mm, while the lowest ear diameter was observed in the POP3 genotype at 25.8 mm. In the second year, the lowest ear diameter was observed in the POP10 genotype at 30.5 mm, while the highest value was recorded in Standard2 with 41.8 mm. Among the local genotypes, POP9, POP12, and POP14 stood out in terms of ear diameter (Table 6).

Ear Weight (g): In both experimental years, the highest ear weight was observed in the Standard1 hybrid variety. In the first year, the highest ear weight in the local populations was 113.5 g in POP9, while the lowest weight was recorded as 52.4 g in POP11. In the second year, again, the standard varieties had higher ear weights compared to the local populations, with POP3, POP7, POP8, and POP9 standing out in terms of this characteristic (Table 6). Standard varieties are hybrid materials and since there are popcorn varieties among local genotypes, it is normal for ear weight in local genotypes to be lower than hybrid varieties. Since ear weight directly affects yield, it is an important parameter in maize breeding research.

Table 6. Average values of ear diameter and ear weight according to years and populations.

	Ear Diameter (mm)			Ear Weight (g):		
Populations	**2021**	**2022**	**Average**	**2021**	**2022**	**Average**
Pop1	33.9 cb	36.5 bcd	35.1 bc	86.1 bc	93.7 cd	89.8 bcd
Pop2	32.6 cd	33.9 cde	33.2 cd	85.8 bc	85.3 cd	85.5 bcd
Pop3	25.8 f	36.7 bcd	31.3 cde	73.8 cd	116.1 bc	94.9 bc
Pop4	30.7 cde	32.6 d-e	31.6 cde	74.8 cd	104.2 bcd	89.5 bcd
Pop5	30.9 cde	33.7 cde	32.3 d-e	70.1 cde	104.7 bcd	87.4 bcd
Pop6	31.0 cde	34.1 cde	32.5 cde	56.8 cde	93.1 cd	75.0 bcd
Pop7	29.2 def	35.9 bcd	32.6 cde	54.6 cde	124.6 abc	89.6 bcd
Pop8	27.3 ef	34.5 cde	30.9 d-e	57.8 cde	112.5 bcd	85.2 bcd
Pop9	37.8 b	37.6 abc	37.7 b	113.5 b	105.3 bcd	109.4 b
Pop10	27.6 ef	30.5 e	29.1 e	56.1 cde	73.1 d	64.6 cd
Pop11	30.8 cde	32.6 de	31.7 cde	52.4 de	79.9 cd	66.2 cd
Pop12	30.6 cde	37.4 a-d	34.0 bcd	62.9 cde	90.1 cd	76.5 bcd
Pop13	28.9 def	34.2 cde	31.5 cde	38.7 e	80.8 cd	59.8 d
Pop14	30.1 df	37.7 abc	33.9 bcd	72.0 cd	99.7 bcd	85.9 bcd
Standard1	49.9 a	40.7 ab	45.3 a	258.3 a	167.3 a	212.8 a
Standard2	48.1 a	41.8 a	44.9 a	229.8 a	165.8 a	197.8 a
Average	**32.8 B**	**35.6 A**	**34.2**	**90.2 B**	**106 A**	**98.1**

Grain Weight per Cob (g): The grain weight per cob in colored local populations ranged between 46.3 g and 93.7 g across the years. In standard varieties, the average grain weight per cob was significantly higher, reaching 173.2 g. In the first year, the genotype with the lowest grain weight per cob was POP13 (27.9 g), while the highest average was observed in Standard 2 (204.9 g). During the second trial year, the highest grain weight per cob was recorded in POP7 (107.1 g), whereas the lowest weight was found in POP10 (55 g). Among the colored village populations, POP9, POP5, and POP7 were identified as promising genotypes in terms of grain weight per cob.

Table 7. Average values of ear grain weight and ear grain number according to years and populations.

	Grain Weight per Cob (g)			Number of Grains per Cob		
Populations	**2021**	**2022**	**Average**	**2021**	**2022**	**Average**
Pop1	67.8 cd	74.0 cd	70.9 bc	423,1 b-e	470,2 bcd	446,6 cd
Pop2	71.6 c	69.9 cd	70.7 bc	470.2 b-d	601.2 ab	535.7 abc
Pop3	59.4 cde	85.1 bcd	72.2 bc	419,3 b-e	653,1 a	536,2 abc
Pop4	57.6 cde	84.9 bcd	71.2 bc	621,6 ab	601,2a b	611,4 ab
Pop5	59.3 cde	95.5 bcd	77.4 bc	378,8 c-g	630,5 a	504, bc
Pop6	40.5 def	73.2 cd	56.8 c	381,4 c-g	463,1 b-e	422,3 cd
Pop7	43.1 c-f	107.1 abc	75.1 bc	319,3 de	527,3 abc	423,1 cd
Pop8	45.5 c-f	97.1 bc	71.3 bc	300,2 fg	466,2 b-d	383,2 de
Pop9	100.7 b	86.7 b-d	93.7 b	598,8 ab	552,8 ab	575,8 ab
Pop10	37.6 ef	55.0 d	46.3 c	352,9 c-g	479,5 bcd	416,2 cd
Pop11	33.9 ef	67.7 cd	50.9 c	271,2 fg	421, b-e	346,1 e
Pop12	38.4 ef	70.6 cd	54.5 c	260,6 g	388,4 cde	324,5 e
Pop13	27.9 f	65.6 cd	46.8 c	330,3 fg	509,2 abc	419,6 cd
Pop14	55.9 c-f	85.9 bcd	70.9 bc	442,2 bcd	522,6 abc	482,4 bc
Standard1	204.9 a	141.5 a	173.2 a	613,8 ab	645,7 a	629,7 a
Standard2	203.4 a	143.2 a	173.3 a	656,7 a	582,4 ab	619,5 a
Average	**71.7 B**	**87.6 A**	**79.7**	**378,2 B**	**519,6 A**	**470,5**

Number of Grains per Cob: In the first year, the highest number of grains per cob was observed in the Standard2 genotype, while the lowest was recorded in the POP12 genotype. Among the colored village populations, POP4 and POP9 stood out as the genotypes with the highest number of grains in the first year, whereas in the second year, POP5 and POP3 were identified as the genotypes with the highest grain counts. Some local genotypes exhibited grain counts close to those of standard varieties, likely due to the smaller grain structure characteristic of the colored village populations.

Conclusion

The study revealed a significant and broad variation in the traits examined among the colored local maize genotypes used in the experiment. Among the genotypes, POP13 and POP11 were identified as potential source materials for developing late-maturing varieties, while the POP2 genotype was deemed suitable for use as a source material in breeding early-maturing varieties. The genotypes POP4 and POP14 stood out as they were statistically grouped with standard hybrid varieties in terms of plant height. These genotypes could serve as valuable source materials for developing colored local silage varieties. For improving first ear height, the genotypes POP3 and POP14 were identified as promising candidates, while for cob length, the genotypes POP2, POP3, POP4, and POP8 could be utilized as source materials in a variety development programs. Based on the results obtained for cob grain weight, which directly affects grain yield-one of the most critical parameters for the genotypes POP5, POP7, and POP9 demonstrated the highest average grain yield. Utilizing these genotypes in breeding programs for developing colored local maize varieties would be valuable for improvement efforts. Significant differences were observed between colored local maize genotypes and standard hybrid varieties in terms of cob weight, cob grain weight, and the number of grains per cob. Commercial hybrid varieties, which are commonly used as standards, exhibited better performance in terms of these characteristics compared to the colored local genotypes. However, based on the results obtained from plant height, first cob height, and cob length data, it was observed that local colored populations showed values similar to or even higher than those of the hybrid varieties. The results indicate significant variation in the plant characteristics of the materials used in the study, and it has been concluded that evaluating these genotypes in breeding programs would be beneficial.

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Authors' Contributions

Authors declare that they have contributed equally to the article.

Conflicts of Interest

The authors declare that there is no conflict of interest.

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