



Morpho-Physiological and Grain Yield Performance of Maize (*Zea mays* L.) Varieties Across Two Agro-Ecological Zones of Taraba State, Nigeria

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ABSTRACT

Maize (*Zea mays* L.) is an important cereal crop that contributes significantly to food security, livestock feed production, and household income in Taraba State, Nigeria. This study evaluated the morpho-physiological and grain yield performance of ten maize varieties under the Northern Guinea Savanna (Jalingo) and Southern Guinea Savanna (Wukari) agro-ecological zones of Taraba State. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data collected on growth, phenological, and yield traits were subjected to Analysis of Variance (ANOVA), while means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability level. The results showed significant ($p < 0.05$) differences among varieties for most traits measured, indicating substantial genetic variability. TELA and SAMMAZ50 consistently produced superior values for plant height, ear characteristics, cob weight, grain weight, and kernel number, resulting in the highest grain yields across locations. SAMMAZ51 exhibited the largest leaf area and leaf area index, indicating superior vegetative growth, while SAMMAZ52 and SAMMAZ24 flowered earlier and were better suited to shorter growing seasons. Local White and Local Yellow generally recorded the lowest performance for most parameters. Maize varieties performed better under Wukari conditions than in Jalingo, suggesting a more favourable production environment in the Southern Guinea Savanna. The study concludes that improved maize varieties, particularly TELA and SAMMAZ50, possess superior adaptability and yield potential across the agro-ecological zones of Taraba State and are therefore recommended for increased maize production.

Keywords: Maize varieties, morpho-physiological traits, grain yield, agro-ecological zones, Taraba State, genotype performance.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops globally due to its wide adaptability, high yield potential, and diverse uses as food, livestock feed, and industrial raw material. Globally, maize production increased from about 820 million metric tonnes in 2009 to over 1.1 billion metric tonnes in recent years, reflecting its growing importance in global food systems (FAOSTAT, 2024). The United States, China, and Brazil are currently

the three largest maize-producing countries in the world, contributing more than 60% of global output. In the 2024/2025 production season, the United States produced about 377.6 million metric tonnes, China 292 million metric tonnes, and Brazil 129.5 million metric tonnes of maize. In Africa, maize remains the most widely cultivated cereal crop and serves as a major source of calories for millions of people. Africa produced over 96 million metric

tonnes of maize in 2024, accounting for approximately 8% of global production. South Africa, Nigeria, and Ethiopia are the leading maize-producing countries on the continent. South Africa produced about 13.4 million metric tonnes, Nigeria 11.05 million metric tonnes, and Ethiopia 10.2 million metric tonnes during the 2023/2024 production season.

Nigeria occupies a strategic position in African maize production, ranking second in Africa and among the top fifteen maize-producing countries globally. National maize production reached approximately 11.16 million metric tonnes in 2024, cultivated on about 5.5 million hectares of land. Maize contributes significantly to Nigeria's agricultural economy through food supply, livestock feed manufacturing, brewing industries, starch production, and household income generation. It constitutes about 60–65% of poultry feed ingredients and supports one of the largest livestock feed industries in sub-Saharan Africa. Previous reports indicated that maize production in Nigeria increased from about 10 million metric tonnes in 2020 to over 11.6 million metric tonnes in 2021, demonstrating its growing economic importance.

Within Nigeria, Taraba State is one of the important maize-producing states in the Guinea Savanna region. Agriculture constitutes the major livelihood activity of the population, with maize ranking among the most dominant crops cultivated across the state, second only to rice in production importance. The state lies within both the Northern Guinea Savanna and Southern Guinea Savanna agro-ecological zones, providing favorable conditions for maize cultivation. Available production reports indicate that Taraba contributes approximately 5% of Nigeria's total maize output. Major maize varieties cultivated in the state include improved varieties such as SAMMAZ19, SAMMAZ22, SAMMAZ24, SAMMAZ25, SAMMAZ50, SAMMAZ51, SAMMAZ52, and TELA, alongside local varieties commonly referred to as Local Yellow and Local White.

Despite the availability of these improved varieties, considerable variation exists in their

growth performance, maturity period, adaptability, and grain yield across different locations within the state. Differences in rainfall distribution, soil fertility, temperature regime, and other environmental factors often result in genotype $\times$ environment interactions that influence varietal productivity. Thus, farmers frequently experience inconsistent yields due to inadequate information on the most suitable varieties for specific agro-ecological conditions. Although several studies have evaluated maize performance in different parts of Nigeria, location-specific information on the morpho-physiological and yield performance of improved maize varieties across the major agro-ecological zones of Taraba State remains limited. This knowledge gap has constrained effective varietal recommendation, seed adoption, and productivity improvement efforts.

Maize is one of the most important cereal crops in Nigeria and serves as a major source of food, livestock feed, industrial raw materials, and income for farming households. In Taraba State, maize is among the most widely cultivated crops and ranks second only to rice in terms of production importance. Despite the availability of several improved maize varieties developed by research institutions, farmers continue to experience inconsistent yields due to differences in varietal adaptation to specific agro-ecological conditions. The Northern Guinea Savanna (Jalingo) and Southern Guinea Savanna (Wukari) zones of Taraba State differ considerably in rainfall pattern, temperature, soil characteristics, and other environmental factors that influence maize growth and productivity. Consequently, maize varieties often exhibit different growth responses, maturity periods, and yield potentials across locations due to genotype $\times$ environment interactions. Farmers frequently cultivate varieties based on availability rather than scientifically validated performance information, resulting in suboptimal productivity.

Although numerous improved maize varieties such as TELA, SAMMAZ19, SAMMAZ22, SAMMAZ24, SAMMAZ25, SAMMAZ50,

SAMMAZ51, and SAMMAZ52 have been released for cultivation in Nigeria, limited information exists on their comparative morpho-physiological characteristics and grain yield performance under the contrasting agro-ecological conditions of Taraba State. Furthermore, information on the relationships among growth, phenological, and yield traits that could aid varietal selection and breeding efforts remains inadequate. This study is therefore justified because it provides location-specific information on the growth, development, and yield performance of selected maize varieties in Taraba State. The findings will assist farmers in selecting suitable varieties for improved productivity, guide extension agents in making appropriate recommendations, and provide useful information for plant breeders and researchers involved in maize improvement programmes. Ultimately, the study will contribute to increased maize production, enhanced food security, and sustainable agricultural development in the state and Nigeria at large.

The specific objectives were to:

- i. Evaluate the growth characteristics of ten maize varieties using plant height, number of leaves, stem girth, leaf area, total leaf area, and leaf area index under the two agro-ecological zones.
- ii. Assess the phenological characteristics of the maize varieties using days to 50% tasseling and days to 50% silking.
- iii. Determine the germination and early growth performance of the maize varieties under the study locations.
- iv. Evaluate ear and morphological traits of the maize varieties, including ear diameter, ear length, and ear weight.
- v. Assess the grain yield and yield-related traits of the maize varieties, including grain weight, cob weight, cob weight per hectare, threshing percentage, hundred-seed weight, and number of kernels per row.

MATERIALS AND METHODS

Study Areas

The study was conducted during the 2024 cropping season at two locations with distinct agro-ecological zones in Taraba State, Nigeria. The first experimental site was located at the Teaching and Research Farm of Taraba State University, Jalingo (08°05'2" N, 11°02'2" E), within the Northern Guinea Savanna zone, at an altitude of approximately 349 m above sea level. The area experiences a tropical wet-and-dry climate with mean annual rainfall ranging from 800 to 1,063 mm between April and October. The predominant soil type is sandy clay loam, well-drained and moderately fertile, suitable for arable crop production. The second site was located at the Teaching and Research Farm of Federal University Wukari (07°50'37" N, 09°46'31" E), situated in the Southern Guinea Savanna zone at an elevation of about 187 m above sea level. The area has a warm tropical climate with a relatively longer growing season and higher biomass potential. Soils range from sandy loam to loamy and are moderately rich in organic matter, providing a favorable environment for maize production.

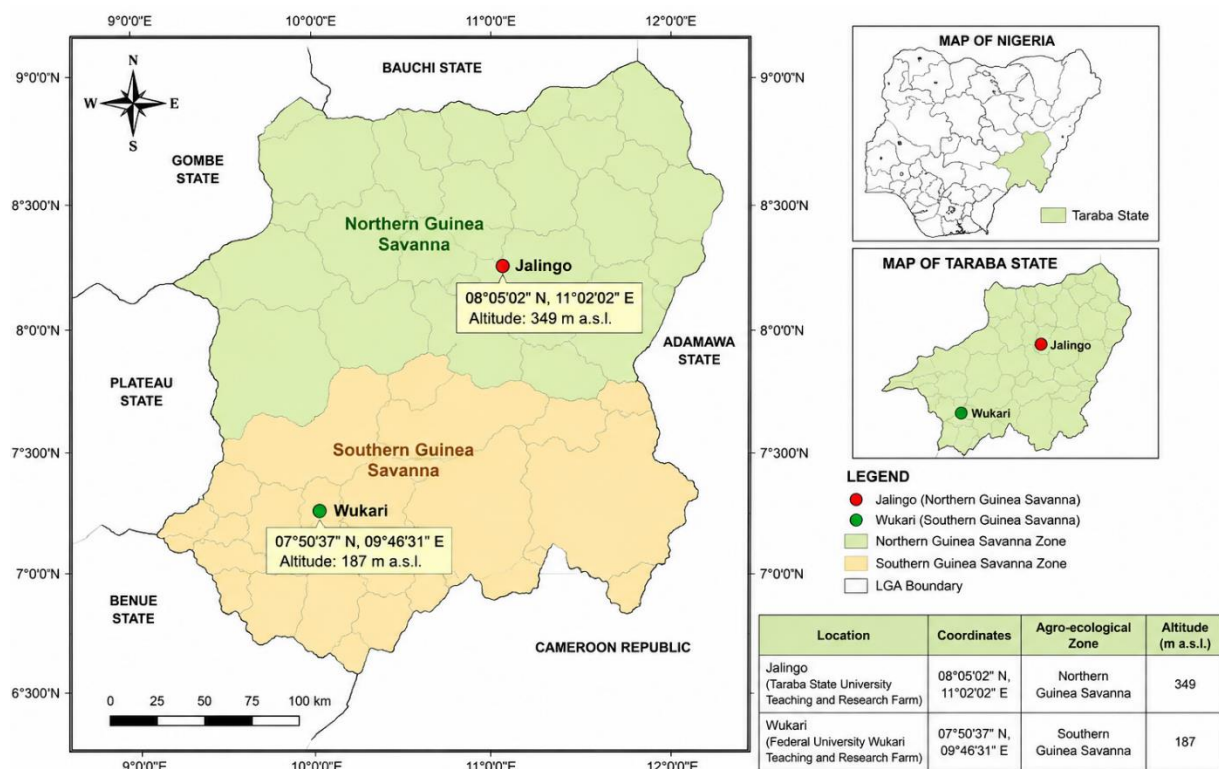


Figure 1: Map of Taraba State, Nigeria showing the study locations

Figure 1: Map of Taraba State, Nigeria showing the study location

Source: Adapted from the Administrative Map of Taraba State obtained from the Office of the Surveyor General of the Federation (OSGOF), Nigeria, and modified by the researcher using ArcGIS 10.8 (2025).

Experimental Materials

Ten maize (*Zea mays* L.) varieties were evaluated, consisting of eight improved varieties obtained from the Institute for Agricultural Research, Ahmadu Bello University, Zaria, and two local landraces sourced from farmers within Taraba State. The improved varieties included SAMMAZ 22, SAMMAZ 24, SAMMAZ 25, SAMMAZ 50, SAMMAZ 51, SAMMAZ 52, SAMMAZ 19, and TELA maize, while the local checks were Local White and Local Yellow.

Experimental Design and Field Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications at each location. Each plot measured 3 m × 3 m and consisted of four ridges. A spacing of 1.5 m was maintained between replicates and 1.0 m between plots. Maize was planted at 75 cm inter-row and 25 cm intra-row spacing.

Crop Establishment and Management

Seeds were treated with Apron Star 52 DS at the rate of one sachet per 4 kg of seed before planting. This seed treatment was carried out to protect the seeds and emerging seedlings against seed-borne and soil-borne pathogens, as well as early insect pests,

thereby ensuring better germination, seedling establishment, and uniform crop stand. Sowing was done manually in August 2024, with two seeds planted per hole at a depth of approximately 3 cm to enhance emergence and ensure adequate plant population in case of poor germination. The seedlings were later thinned to one plant per stand two weeks after sowing to reduce competition among plants for nutrients, moisture, sunlight, and space, resulting in an optimum plant population of 53,333 plants ha⁻¹. Maintaining the recommended plant population was essential for achieving maximum growth and yield performance while ensuring uniformity across experimental plots. Standard agronomic practices, including weeding, fertilizer application, and pest management, were applied uniformly across all treatments to minimize environmental variation and ensure that observed differences among varieties were primarily due to genetic factors rather than management effects.

Data Collection

Five plants were randomly selected and tagged per plot for growth and yield measurements. Plant height, number of leaves, stem girth, leaf area, leaf area index,

and days to 50% tasselling and silking were recorded at 3, 6, 9, and 12 weeks after sowing. Yield attributes including ear length, ear diameter, ear weight, kernel rows per ear, kernels per row, harvest index, threshing percentage, grain yield (kg ha^{-1}) were measured at harvest and 100-grain weight.

Soil Sampling and Analysis

Prior to the commencement of the experiment, composite soil samples were collected from different spots under the different experimental locations with the use of soil auger at 0-15cm, depth and were analyzed at the Department of Soil Science Laboratory, Federal University Wukari. These was bulked together, air-dried, crushed in a mortar to break the soil clods and sieved with a 2mm sieve to remove large particles, debris and pebbles. Routine analysis was carried out to determine the physical and chemical properties of the soil. Soil pH was measured with the glass electrode pH meter in a 1:1 soil to water and 2:1 soil to CaCl_2 ratio as prescribed by (Nelson and Somers, 2016). The organic carbon was determined by the Walkley and Black method (Nelson and Somers, 2016). Total nitrogen (N) was determined by the micro Kjeldahl method (Bremmer, 2018), while available Phosphorus (P) was extracted by Bray method (Bray and Kurtz, 2017) and read with the spectrophotometer. Potassium, calcium, sodium and magnesium were extracted using NH_4OAC , then K, Na, and Ca were determined using the flame photometer, while Mg was read with atomic absorption spectrophotometer (AAS). Soil textural analysis to be done by hydrometer method, as described by Odu *et al.*, (2015). Mechanical analysis of the soil was carried out by the Bouycous hydrometer method as described by Gee and Bauder (1986). Soil pH was measured using Mclwan (1982) method and organic carbon content were determined using weight combustion method as prescribed my Nelson and Sommers (1982). Catio exchange capacity

(CEC) of the soil was determined by ammonium acetate method as described by Thomas (1982). Total Nitrogen was determined using mico Keidahl method as described by Bremmer and Mulvancy (1982).

Data Analysis

Data collected from the field experiment were subjected to both descriptive and inferential statistical analyses. Descriptive statistics (means and percentages) were used to summarize soil physico-chemical properties and measured agronomic traits. Inferential statistics were performed using Analysis of Variance (ANOVA) appropriate for a Randomized Complete Block Design (RCBD) to determine the significance of varietal effects within and across locations. The analysis was carried out using GenStat Statistical Software (18th Edition, VSN International Ltd., UK). Where significant differences were detected at the 5% probability level ($P < 0.05$), treatment means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Soil Physico-Chemical Properties of Experimental Sites

The results in Table 1 showed that Wukari soils generally contained higher nutrient levels than Jalingo soils. Soil pH ranged from 5.92 to 6.45, indicating slightly acidic conditions suitable for maize production. Organic carbon (1.12%), organic matter (1.93%), total nitrogen (0.10%), available phosphorus (7.6 mg kg^{-1}), exchangeable potassium ($0.18 \text{ cmol}(+) \text{ kg}^{-1}$), calcium ($4.15 \text{ cmol}(+) \text{ kg}^{-1}$), magnesium ($1.08 \text{ cmol}(+) \text{ kg}^{-1}$), and cation exchange capacity ($11.7 \text{ cmol}(+) \text{ kg}^{-1}$) were higher in Wukari than in Jalingo. The soils were classified as sandy clay loam in Wukari and sandy loam in Jalingo.

Furthermore, the soil analysis in Table 1 revealed differences between the two experimental locations. Wukari recorded higher values of organic carbon (1.12%),

organic matter (1.93%), total nitrogen (0.10%), available phosphorus (7.60 mg kg⁻¹), exchangeable potassium (0.18 cmol(+) kg⁻¹), calcium (4.15 cmol(+) kg⁻¹), magnesium (1.08 cmol(+) kg⁻¹), and cation exchange capacity (11.70 cmol(+) kg⁻¹) compared with Jalingo. These results suggest relatively better soil fertility status in Wukari, which may partly explain the

superior growth and yield performance observed in that location. The higher nutrient status in Wukari is consistent with the higher organic matter content, which improves nutrient retention and availability to crops. Similar observations were reported by Kamara *et al.* (2020), who noted that maize productivity in the Guinea Savanna is strongly influenced by soil fertility status.

Table 1: Average Soil Physico-Chemical Properties of the two locations

Parameter	Unit of Measurement	Wukari (Southern Guinea Savanna)	Jalingo (Northern Guinea Savanna)
Soil pH (H ₂ O)	pH (unitless)	6.45	5.92
Soil pH (CaCl ₂)	pH (unitless)	5.78	5.31
Organic Carbon (OC)	%	1.12	0.42
Organic Matter (OM)	%	1.93	0.72
Total Nitrogen (N)	%	0.10	0.06
Available Phosphorus (P)	mg kg ⁻¹	7.6	3.9
Exchangeable Potassium (K)	cmol(+) kg ⁻¹	0.18	0.12
Exchangeable Calcium (Ca)	cmol(+) kg ⁻¹	4.15	2.70
Exchangeable Magnesium (Mg)	cmol(+) kg ⁻¹	1.08	0.81
Cation Exchange Capacity (CEC)	cmol(+) kg ⁻¹	11.7	7.8
Electrical Conductivity (EC)	dS m ⁻¹	0.14	0.09
Bulk Density	g cm ⁻³	1.41	1.46
Soil Texture	Textural class	Sandy clay loam	Sandy loam
Elevation	m above sea level (m a.s.l.)	349	187

Source: Laboratory soil analysis (2024)

Vegetative Traits of Maize Varieties under Jalingo Conditions

The vegetative performance of maize varieties under Jalingo conditions is presented in Table 2. Significant differences ($P < 0.05$) were observed for number of leaves, stem girth, leaf area, leaf area index, days to tasselling, and days to silking, whereas plant height did not differ significantly among varieties. TELA recorded the highest number of leaves (13.77), while SAMMAZ52 produced the least (11.23). SAMMAZ50 recorded the highest stem girth (2.68 cm), whereas TELA and Local White had the lowest values (2.06 cm). SAMMAZ51 produced the largest leaf area (508.27 cm²) and leaf

area index (4.07), while Local White recorded the lowest values. Early flowering was observed in SAMMAZ52 and SAMMAZ51, which tasselled and silked significantly earlier than the other varieties.

The significant differences observed among the maize varieties for vegetative growth traits indicate the existence of substantial genetic variability among the tested genotypes. Variations in plant growth characteristics such as plant height, leaf production, stem girth, leaf area, and leaf area index are largely influenced by the genetic makeup of the varieties and their interaction with the environment. The superior canopy development exhibited by

some improved varieties, particularly SAMMAZ51, suggests a greater capacity for light interception and photosynthetic activity, which are important determinants of biomass accumulation and subsequent grain production. Similar observations were reported by Badu-Apraku and Fakorede (2017), who noted that maize genotypes possessing larger leaf area and improved canopy architecture generally achieve higher productivity because of enhanced radiation use efficiency.

The early flowering behaviour observed in some improved varieties demonstrates their suitability for environments characterized by short growing seasons or erratic rainfall patterns. Early tasselling and silking enable maize plants to complete critical reproductive stages before the onset of moisture stress, thereby improving adaptation and yield stability. This finding agrees with the report of Shiferaw et al. (2011), who stated that early-maturing maize cultivars provide an effective strategy for reducing the adverse

effects of climate variability in sub-Saharan Africa.

The generally poorer vegetative performance exhibited by the local varieties may be attributed to their lower genetic potential and limited improvement through breeding programmes. Improved maize varieties are specifically developed to possess superior growth vigour, better nutrient-use efficiency, and greater tolerance to environmental stresses. Similar conclusions were reached by International Maize and Wheat Improvement Center (2023), which reported that improved maize cultivars consistently outperform traditional landraces in growth, adaptation, and productivity across diverse agro-ecological conditions. Therefore, the observed superiority of the improved varieties highlights the importance of adopting genetically enhanced cultivars for sustainable maize production in both the Northern and Southern Guinea Savanna zones of Taraba State.

Table 2: Mean Vegetative Traits of Maize Varieties under Jalingo Conditions

Variety	PH (cm)	NL	SG (cm)	LA (cm ²)	LAI	DFT	DFS
TELA	193.40a	13.77a	2.06d	481.30ab	3.60ab	55.00a	61.33a
SAMMAZ50	192.40a	13.03ab	2.68a	485.07ab	3.63ab	54.67a	58.33b
SAMMAZ24	164.60a	12.30abc	2.35bcd	448.97abc	3.37bc	54.33a	58.67ab
SAMMAZ19	184.90a	12.10bc	2.22cd	420.33bc	3.17bc	55.00a	58.00b
SAMMAZ25	158.33a	13.00ab	2.54ab	466.40abc	3.50b	54.00a	58.67ab
SAMMAZ52	157.67a	11.23c	2.09d	454.43abc	3.40b	45.00b	49.33c
SAMMAZ51	181.07a	11.83bc	2.44abc	508.27a	4.07a	45.33b	49.00c
Local Yellow	176.23a	12.20abc	2.16cd	439.30abc	3.30bc	53.33a	58.00b
SAMMAZ22	163.20a	12.43abc	2.39abc	478.43abc	3.60ab	54.00a	58.00b
Local White	145.57a	11.87bc	2.06d	394.13c	2.93c	55.00a	58.67ab

Key: PH = Plant Height (cm), NL = Number of Leaves (count), SG = Stem Girth (mm), LA = Leaf Area (cm²), LAI = Leaf Area Index (dimensionless), DFT = Days to 50% Tasselling (days), DFS = Days to 50% Silking (days).

Yield-Related Traits of Maize Varieties under Jalingo Conditions

Significant differences ($P < 0.05$) were observed among varieties for grain weight, cob weight, cob weight per hectare, threshing percentage, hundred-seed weight, and number of kernels per row (Table 3). TELA produced the highest grain weight (4876.67 g), cob weight (2510.67 g), and cob weight per hectare (5579.00 kg ha⁻¹), followed by SAMMAZ50. Local White recorded the lowest grain weight (1594.67 g) and threshing percentage (62.67%). TELA also produced the highest hundred-seed weight (24.20 g), while SAMMAZ50 recorded the highest number of kernels per row (15.43). The superior yield performance observed in TELA and SAMMAZ50 suggests that these improved varieties possess greater genetic potential for efficient assimilate production, translocation, and partitioning to reproductive structures. Their higher grain weight, cob weight, hundred-seed weight, and kernel number indicate improved sink strength and grain-filling ability. Grain yield in maize is largely determined by the interaction of yield components such as kernel number, kernel size, and cob characteristics, which collectively influence the final economic yield (Badu-Apraku and Fakorede, 2017). The outstanding performance of TELA and SAMMAZ50 therefore reflects their enhanced capacity to convert photosynthates into grain more efficiently than the other varieties evaluated.

The relatively high threshing percentage recorded by most improved varieties further indicates better grain development and a greater proportion of grain relative to cob biomass. According to Ranum et al. (2014), improved maize cultivars are

generally characterized by enhanced grain-filling efficiency, resulting in higher grain recovery and overall productivity. This may explain the superior threshing percentages observed in TELA and SAMMAZ50 compared with the local varieties. The poor yield performance of Local White across most yield parameters highlights the limitations of traditional landraces under improved production conditions. Lower grain weight, smaller seed size, fewer kernels per row, and reduced threshing percentage suggest a lower capacity for assimilate accumulation and utilization during reproductive development. Similar findings were reported by Shiferaw et al. (2011), who noted that local maize varieties generally exhibit lower yield potential because they have not undergone systematic genetic improvement for enhanced productivity and stress tolerance.

The moderate performance of varieties such as SAMMAZ52, SAMMAZ25, and SAMMAZ22 indicates that although they may not possess the yield potential of TELA and SAMMAZ50, they still offer considerable advantages over local cultivars. Their ability to produce acceptable grain yields while maintaining relatively early maturity may be beneficial in environments where rainfall duration is uncertain or where farmers prefer shorter production cycles. According to the International Maize and Wheat Improvement Center (CIMMYT, 2019), the adoption of improved maize varieties with desirable yield and adaptation traits remains one of the most effective strategies for increasing maize productivity and enhancing food security in sub-Saharan Africa.

Table 3: Yield-Related Traits of Ten Maize Varieties under Jalingo Conditions

Variety	GW (g)	CW (g)	CWKG (g)	TP (%)	HSW (g)	NKR
TELA	4876.67a	2510.67a	5579.00a	87.33a	24.20a	15.37ab
SAMMAZ50	3913.00b	2000.33b	4445.00b	88.00a	23.67ab	15.43a
SAMMAZ24	2118.33cd	1151.67c	2559.00c	83.00ab	20.00ab	14.63abcd
SAMMAZ19	2399.00c	1314.33c	2920.30c	82.00ab	23.13ab	12.17ed
SAMMAZ25	2141.67cd	1132.33c	2516.00c	85.00ab	19.90ab	15.03abc
SAMMAZ52	2138.33cd	1155.67c	2568.00c	83.33ab	22.17ab	12.90abcde
SAMMAZ51	2127.67cd	1139.00c	2530.70c	84.33ab	21.27ab	11.90ed
Local Yellow	2100.33cd	1264.67c	2810.00c	75.00b	21.80ab	12.47cde
SAMMAZ22	1918.33cd	1054.33c	2342.70c	81.67ab	21.03ab	12.60bcde
Local White	1594.67d	1143.67c	2414.30c	62.67c	19.10b	10.43e

Key: Means followed by the same letter(s) within a column are not significantly different at the 5% probability level according to Duncan's Multiple Range Test (DMRT). GW = Grain Weight; CW = Cob Weight; CWKG = Cob Weight per hectare; TP = Threshing Percentage; HSW = Hundred Seed Weight; NKR = Number of Kernels per Row.

Vegetative Traits of Maize Varieties under Wukari Conditions

Table 4 shows significant varietal differences ($P < 0.05$) for all vegetative and phenological traits evaluated under Wukari conditions. SAMMAZ51 recorded the tallest plants (215.57 cm), largest leaf area (508.27 cm²), and highest leaf area index (4.07). SAMMAZ50 produced the thickest stem girth (2.68 cm), while SAMMAZ25 recorded the highest number of leaves (15.03). TELA had the longest duration to tasselling (57.67 days) and silking (62.33 days), whereas SAMMAZ24 flowered earliest. The

superior vegetative growth recorded in Wukari compared with Jalingo may be associated with the higher soil fertility and favourable environmental conditions observed at the site. The outstanding performance of SAMMAZ51 suggests strong adaptation and efficient utilization of available resources. Enhanced leaf area and LAI increase photosynthetic efficiency, leading to greater dry matter accumulation and eventual yield improvement. Similar findings have been reported by Ranum et al. (2014), who emphasized the importance of canopy development in maize productivity.

Table 4: Mean Vegetative Traits of Maize Varieties under Wukari Conditions

Variety	PH	NL	SG	LA	LAI	DFT	DFS
TELA	196.83ab	14.77ab	2.06d	481.30ab	3.60ab	57.6667a	62.3333a
SAMMAZ50	202.33ab	13.57ab	2.68a	485.07ab	3.63ab	55.3333ab	60.6667a
SAMMAZ24	174.93ab	13.40ab	2.35bcd	448.97abc	3.37bc	46.0000c	51.6667c
SAMMAZ19	186.50ab	13.73ab	2.22cd	420.33bc	3.17bc	5.3333ab	60.0000a
SAMMAZ25	199.90ab	15.03a	2.54ab	466.40abc	3.50b	48.3333c	55.6667bc
SAMMAZ52	175.03ab	13.20b	2.09d	454.43abc	3.40b	56.6667ab	60.3333a
SAMMAZ51	215.57a	14.33ab	2.44abc	508.27a	4.07a	56.0000ab	59.0000ab
Local Yellow	171.53ab	14.17ab	2.16cd	439.30abc	3.30bc	56.0000ab	61.3333a
SAMMAZ22	168.03b	13.47ab	2.39abc	478.43abc	3.60ab	54.6667b	58.3333ab
Local White	167.60b	13.70ab	2.06d	394.13c	2.93c	56.0000ab	60.0000a

Key: PH = Plant Height (cm), NL = Number of Leaves (count), SG = Stem Girth (mm), LA = Leaf Area (cm²), LAI = Leaf Area Index (dimensionless), DFT = Days to 50% Tasselling (days) and DFS = Days to 50% Silking (days).

Yield-Related Traits of Maize Varieties under Wukari Conditions

Yield-related traits differed significantly ($P < 0.05$) among the maize varieties (Table 5).

TELA recorded the highest grain weight (6051.23 g), cob weight (3010.33 g), cob weight per hectare (6689.0 kg ha⁻¹), hundred-seed weight (26.87 g), and number of kernels per row (16.73). SAMMAZ50 ranked second for most yield parameters. Local White consistently recorded the lowest values for grain weight, cob weight, threshing percentage, and hundred-seed weight.

The superior yield performance exhibited by TELA and SAMMAZ50 under Wukari conditions demonstrates the importance of genetic improvement in enhancing maize productivity. Their outstanding performance across yield components suggests greater efficiency in photosynthate production, translocation, and utilization for grain development. Grain yield in maize is largely dependent on the interaction of key yield components such as cob weight, kernel number, and seed weight, which collectively determine the final economic yield. The high performance of these varieties indicates their

strong adaptability to the Southern Guinea Savanna environment and their ability to effectively utilize available environmental resources for grain production. The comparatively higher yields obtained in Wukari than in Jalingo may be attributed to the more favorable soil conditions observed at the site, particularly higher organic matter, nitrogen, phosphorus, exchangeable bases, and cation exchange capacity. Improved soil fertility enhances nutrient availability, promotes vigorous vegetative growth, and supports efficient grain filling. Similar observations were reported by Badu-Apraku and Fakorede (2017), who noted that favorable soil and climatic conditions significantly improve the expression of yield-related traits in maize.

The high threshing percentage and seed weight observed in the improved varieties further indicate superior grain filling and assimilate partitioning efficiency. According to Ranum et al. (2014), improved maize cultivars generally possess enhanced physiological mechanisms that promote efficient conversion of biomass into grain yield, resulting in heavier seeds and greater grain recovery after threshing. These

characteristics are important indicators of productivity and market value. The poor performance of Local White across most yield parameters reflects the limitations commonly associated with local landraces, including lower genetic yield potential and reduced responsiveness to improved

agronomic conditions. Similar findings were reported by Shiferaw et al. (2011), who observed that traditional maize varieties often produce lower yields than improved cultivars due to inferior grain filling capacity and reduced tolerance to environmental stresses.

Table 5: Yield-Related Traits of Maize Varieties under Wukari Conditions

Variety	GW	CW	CWKG	TP	HSW	NKR
TELA Maize	6051.23a	3010.33a	6689.0a	90.33a	26.87a	16.73a
SAMMAZ50	5258.73b	2563.33b	5843.9b	90.00a	26.50ab	15.07ab
SAMMAZ52	4001.83c	2063.67c	4585.5c	87.67ab	25.93ab	12.33ab
SAMMAZ19	3140.43d	1567.33de	3487.1de	90.33a	24.37abc	9.53b
SAMMAZ51	3118.20d	1593.33d	3507.0de	88.00ab	25.83ab	13.00ab
SAMMAZ25	3110.10d	1614.00d	3619.6d	86.67ab	24.13bc	15.83a
SAMMAZ22	3107.83d	1607.00d	3570.8d	86.00ab	24.23abc	16.07a
Local Yellow	3082.67d	1658.33d	3684.8d	83.67bc	23.17dc	11.43ab
SAMMAZ24	3066.33d	1680.00d	3673.0d	84.67abc	24.40abc	15.57a
Local White	2522.00e	1419.67e	3154.7e	80.00c	21.17d	9.77b

Key: Means followed by the same letter(s) within a column are not significantly different at the 5% probability level according to Duncan's Multiple Range Test (DMRT). GW = Grain Weight; CW = Cob Weight; CWKG = Cob Weight per hectare; TP = Threshing Percentage; HSW = Hundred Seed Weight and NKR = Number of Kernels per Row.

CONCLUSION

The findings of this study demonstrate clear and consistent varietal differences in the growth, phenological development, and yield performance of maize across the Northern and Southern Guinea Savanna zones of Taraba State. The study demonstrated that significant variations exist among the evaluated maize varieties for growth, phenological, and yield-related traits across the two agro-ecological zones of Taraba State. The observed differences indicate that both genetic makeup and environmental conditions influenced the performance of the maize varieties. Among the varieties evaluated, TELA and SAMMAZ50 consistently exhibited superior performance in most growth and yield parameters, including grain weight, cob weight, kernel

number, and seed weight, indicating high yield potential and wide adaptability across the study locations. SAMMAZ51 showed outstanding vegetative growth characteristics, particularly in leaf area and leaf area index, while SAMMAZ52 and SAMMAZ24 exhibited early maturity traits suitable for areas with shorter growing seasons. The results further revealed that maize varieties generally performed better under Wukari conditions than in Jalingo, suggesting that the Southern Guinea Savanna environment was more favourable for maize growth and yield. Improved varieties consistently outperformed the local checks, particularly Local White, which recorded the lowest values for most growth and yield parameters. Based on the findings of this study, the null hypothesis that there are no

significant differences among maize varieties in their morpho-physiological characteristics and grain yield performance was rejected. The study therefore concludes that TELA and SAMMAZ50 are the most promising varieties for cultivation across the Guinea Savanna zones of Taraba State due to their superior productivity, adaptability, and yield stability.

RECOMMENDATIONS

Based on the findings, the following recommendations are made:

- i. Farmers in the Guinea Savanna zones of Taraba State should adopt high-performing maize varieties such as TELA and SAMMAZ50, which consistently demonstrated superior growth and yield performance across environments.
- ii. Varieties like SAMMAZ51 should be promoted in areas with favorable growing conditions, particularly where enhanced vegetative growth and canopy development are required to maximize photosynthetic efficiency and biomass production.
- iii. Early-maturing varieties such as SAMMAZ52 and SAMMAZ24 should be recommended for regions prone to short growing seasons, delayed rainfall onset, or terminal drought, as they provide a climate-resilient production option.
- iv. Local varieties, especially Local White, should be gradually replaced with improved cultivars for increased productivity; however, they should be conserved within germplasm systems for future breeding and genetic improvement programs.

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