



PHENOTYPIC DIVERSITY OF AGRONOMIC TRAITS IN SELECTED TOMATO (*SOLANUM LYCOPERSICUM* L.) ACCESSIONS IN NASARAWA STATE, NIGERIA

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ABSTRACT: Morphological evaluation of tomatoes accessions is important for breeding and improvement programme on the crop. The lack of understanding on the genetic variation on tomato accession has led to little progress in breeding and improvement of the crop. The experiment was conducted at College of Agriculture, Science and Technology Lafia, Nasarawa State. Five tomato cultivars (Mona F₁, Topaze, Boomerang F₁, Riogrande + and Cirea) were used for the study in a randomized complete block design (RCBD) with three replications. Data were collected on traits such as plant height, number of branches, number of leaves, leaf area, stem girth, number of fruits, fruit weight, days to maturity, fruit girth and shelf life. All the data collected were subjected to Analysis of Variance (ANOVA). Mean separation was carried-out using LSD at probability 5% ($p < 0.05$). The mean performance analysis revealed a significant genotypic difference across all traits. The coefficient of variation (CV) of 11.10% indicated moderate experimental precision. For plant height, Mona F₁ (105.2 cm), Riogrande+ (115.3 cm), Boomerang F₁ (116.7 cm), and Cirea (114.0 cm) formed a statistically similar tall group, while Topaze (88.0 cm) was significantly shorter. Boomerang F₁ produced significantly more leaves (80.9) than all other genotypes, whereas Cirea produced the fewest leaves (28.8). Mona F₁ and Boomerang F₁ exhibited the largest leaf areas (39.77 cm² and 37.6 cm², respectively). Riogrande (+) has longer shelf life (17.67 days), while Cirea had the shortest SL (8.33 days). This showed that the 112% difference is important for post-harvest management. The strongest negative correlation occurred between days to maturity and fruit girth ($r = -0.868$), indicating that late-maturing plants produce significantly smaller fruits. Days to maturity also showed strong negative correlations with fruit weight ($r = -0.743$) and shelf life ($r = -0.694$). Boomerang F₁ showed superior fruit weight and fruit girth, Mona F₁ performed well in fruit number, early maturity, and leaf area, while Riogrande + was outstanding for shelf life and high fruit count, which are useful for breeding and improvement of the crop.

Keywords: Accessions, Characterization, Heritability, Phenotypic diversity, post-harvest.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important and popular fruit vegetable in the world. It is a self-pollinated annual crop and belongs to the family *Solanaceae* with chromosome number $2n=2x=24$ (Peralta *et al.*, 2008; Salim *et al.*, 2020). The phylogenetic classification of the family *Solanaceae* has recently been revised and the genus *Lycopersicon* reintegrated into the genus *Solanum*

with its new nomenclature (Peralta *et al.*, 2008). The clade *Lycopersicon* contains the domesticated tomato *Solanum lycopersicum* L. and its twelve (12) closest wild relatives (Peralta *et al.*, 2005; Peralta *et al.*, 2008). Tomato is generally accepted to have originated in the America also known as the new world. The Andean region which is now encompassed of part of Bolivia, Chile, Colombia, Ecuador and Peru (Peralta *et al.*, 2008; Blanca *et al.*, 2012). Evidence from the diversity of cultivated tomato, all suggested that tomato was originally domesticated in Mexico (Rick *et al.*, 1990). Soon after discovery of the new world, tomato was brought to Europe and gradually spread all over the world (Lin *et al.*, 2014). With the

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expansion of tomato's use, the 20th century was marked by the development of private seed industries which developed the principle of the F₁ hybrid (Bai and Lindhout, 2007). Currently, tomato is the pivotal point of horticultural industry and is growing worldwide either for fresh market or processing (Nowicki *et al.*, 2013).

In Nigeria, tomato is a major fruit vegetable which provides employment to the people hired to work in the farms, and a source of income to the tomato farmers. Tomato fruits contain calories, amino acids, vitamins and minerals (Sainju *et al.*, 2003; Birgen, 2015). An estimated arable area of about 4.2 MT/ha is used for tomato cultivation in Nigeria with an estimated annual production of 3.6 million tons (FAOSTAT, 2021). The versatile vegetable is used for culinary purpose. Ripe tomato fruit is consumed fresh and utilized in the manufacture of wide range of processed products such as paste, powder, ketchup, sauce, soup and canned whole fruits, the unripe green fruits are used for pickles, preserves and are consumed after cooking. In Nigeria, they constitute part of a wide variety of dishes prepared in hotels and homes of different Nigerian communities. The famous 'Nigerian jollof rice' cannot be complete without tomatoes in its recipes (Fagbemi *et al.*, 2021). Tomato fruits contain calories, vitamins and minerals (Birgen, 2015). It is also an important source of lycopene, a phytochemical that protect cells from oxidative damage which have been linked to cancer (Giovannucci *et al.*, 1995). However, raw or cooked tomatoes are considered the best source for this antioxidant (Zu *et al.*, 2014).

Tomato fruits have high water content (about 80%), low pH, and are rich in essential nutrients and sugars, making them suitable medium for microbial growth (Muhammed *et al.*, 2004). Consequently, microbial infections are a major cause of postharvest deterioration, with studies reporting that Nigeria loses approximately 50–90% of its tomato fruits (Bello *et al.*, 2016). In a bid to address these challenges, Owureku-Asare *et al.* (2017) produced consumer-acceptable and longer shelf-life's tomato powder using solar driers. This drying technique (solar drying); even though less expensive and can effectively and efficiently reduce postharvest losses. However, the use of tomato powder is limited food preparation; they are generally being used as an additive (for flavour, taste and colour) during food preparation rather than a main ingredient for soups

and stews as may be desired by the Nigerian consumers (Lavelli *et al.*, 2013). The existing variation in the quantity and quality of the available tomato fruits stems from negative production factors, which include pre-harvest diseases, notably *Alternaria* Stem Canker, black Postharvest fungal and bacterial infections cause fruit rot and spoilage, consequently, negatively affecting the value of the harvested fruits. The spoilt tomatoes end up being discarded by farmers or traders, between harvesting and consumption. These postharvest losses are a reflection of the economic loss to tomato handlers and appropriate agricultural revenue generating agency (Mwangi *et al.*, 2011). Xu and Robinson (2010) however, opined that the quantity of tomato fruits losses after harvest, is determined by the tomato variety and the fruit colour at maturity stage during harvest, and the magnitude and nature of losses is influenced by postharvest handling procedures. The easily damaged varieties easily succumb to injury during postharvest handling (Barkai-Golan, 2001). The level of injury determines the number of postharvest losses because the injuries are avenues through which infection occurs (Oliveri *et al.*, 2013), resulting to the rotting of the fruits. Besides, greater fruits losses are expected when fruits are allowed to over mature (red stage of maturity) before harvest because such fruits are easily damaged (Zhu and Zhang, 2016). The degree of spoilage on the tomatoes harvested at the different fruit colour (green, yellow, red) maturity stages is similarly affected by the postharvest handling procedures (Birgen, 2015), particularly sorting, packaging, transport containers and means of transport (Snowdon, 2010). All these factors cumulatively determine the extent of fruit spoilage by the time they reach the final consumer (Abdallah *et al.*, 2016).

In the study of genetic variations amongst plant species, morphological characters have for a long time remained the most important focused point (Fagbemi *et al.*, 2021). Characterization consists of recording those characters which are highly heritable, can be easily distinguished by naked eye and are expressed in all environments. Before starting any crop improvement programme, it is required to collect available germplasm and their characterization is very important for varietal improvement and selection. Therefore, the study aimed at assessing the phenotypic performance of five tomato genotypes (Mona F₁, Topaze, Riogrande+, Boomerang F₁, and

Cirea) for vegetative traits (plant height, number of branches, leaf number, leaf area, stem girth), yield traits (number of fruits, fruit weight, fruit girth), and post-harvest traits (days to maturity, shelf life), while the objective was to evaluate and characterize the phenotypic diversity and genetic variability of selected tomato accessions.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the College of Agriculture, Science and Technology, Lafia, Nasarawa State, Northern Guinea Savanna of Nigeria and lying between latitude 8.49° N and longitude 8.51° E with an elevation of 150 meters Above Sea Level (ASL). The annual average rainfall is about 456mm per annum, and an average temperature range is about 26.8° C. The soil is mostly sandy-loam and the annual average relative humidity ranges from 60% -70%.

Treatment and Experimental Design

Five tomato genotypes were collected, four of these genotypes, Boomerang F₁, Topaze, Mona F₁, and Riograde plus (+), were sourced from Technisem, a branch of a Research Institute specialized in vegetables and fruits seeds production, while one accession (Cirea) was sourced from a local farmer at Lafia market. Planting was carried-out using Randomized Complete Block Design (RCBD) with three replications amounting to a total of fifteen (15) beds and a total of 72 m² (square meter) plot size. The five (5) genotypes collected planted in three replications.

Cultural Practices

Nursery preparation: Seeds of the five tomato accessions were raised in a nursery bed measuring 1m x 1m for three weeks before transplanting them in the field.

Shading: The nursery beds were mulched and later shaded using palm fronds to protect the seedlings from direct effects of the sun and rainfall.

Watering: Water was applied to the seedlings in the nursery manually twice a week using watering can.

Transplanting: The seedlings were transplanted on the main field at three (3) weeks after nursing them on beds measuring 2m by 1m spacing for both inter- row and intra- row respectively.

Weeding: Weeding was carried-out manually using a hoe at interval of three weeks.

Staking: The tomato plants were supported with sticks in order to keep the plants away from the ground and to also reduce loss of fruits due to rots and sun burn.

Fertilizer application: N. P. K (15: 15: 15) was applied at the rate of 120kg/ha as recommended by Isah *et al.* (2014). Circular groove was drawn about 5 cm away from the base of the plants and fertilizers was carefully applied in the groove and covered lightly with soil.

Data Collection and Statistical Analysis

Data were collected on Plant Height, Number of Branches, Leaf Numbers, Leaf Length, Leaf Width, Leaf Area, Stem Girth, Days to first flowering, Days to 5% Flowering, Fruit Girth, Fruit Weight, Days to Maturity, and Shelf Life. All data collected were subjected to Analysis of variance (ANOVA) using SAS statistical package (SAS 2024), Correlation Analysis, Principal Component Analysis (PCA) and Variance component were also determined. Means were separated using Least Significant Difference (LSD) at Probability of 5% (p<0.05).

RESULTS AND DISCUSSION

The results of analysis of variance (ANOVA) is presented in Table 1. For Plant Height, showed the range of heights for the five genotypes from 88.0 cm (Topaze) to 116.7 cm (Boomerang F₁). Riogrande + (115.3 cm) and Cirea (114.0 cm) had a tall stature. LSD of 20.86 indicated significant variation. Number of Branches (NOB), showed that Mona F₁ and Boomerang F₁ group at 14.0 branches, while Cirea had the fewest (12.0). LSD 1.30 suggests moderate discrimination power. For Leaf Number (LN), Boomerang F₁ produced the most leaves (80.9), followed by Topaze (73.5), while Cirea showed fewer leaves (28.8), representing a 64% reduction compared to Boomerang. This substantial variation (LSD 22.2) indicates strong genetic differences in vegetative growth patterns. For Leaf Area, Mona F₁ (39.77 cm²) and Boomerang F₁ (37.6 cm²) had largest leaves, while Topaze (30.57 cm²) and Riogrande+ (32.0 cm²) had smaller leaves. The result of stem girth showed that, Topaze had thickest stems (1.85 cm), while Mona F₁ had the thinnest stem girth (1.43 cm). For number of fruits (NOF) per plant, Mona F₁ produced most fruits (40.0), followed by Riogrande+ (37.0) and Cirea (36.0), while Topaze had remarkably few fruits

Table 1: Analysis of Variance (ANOVA) for Agronomic Traits of Tomatoes Genotypes

GENOTYPE	PHT	NOB	LN	LA	SG	NOF	FWT	DM	FRWT	SL
Mona F ₁	105.2	14.0	59.3	39.77	1.43	40.0	75.00	76.00	12.73	14.00
Topaze	88.0	13.4	73.5	30.57	1.85	2.06	80.7	81.00	13.79	12.00
Riogrande +	115.3	13.0	61.8	32.0	1.72	37.0	70.2	92.00	13.30	17.67
Boomerang F ₁	116.7	14.0	80.9	37.6	1.60	30.0	91.6	79.00	15.40	14.00
Cirea	114.0	12.0	28.8	32.3	1.53	36.0	57.76	100.0	10.00	8.33
LSD	20.86	1.30	22.2	6.08	0.074	12.0	5.7	6.02	5.00	3.55

LSD= Least significant difference, PHT= Plant height, NOB= Number of branches, LN= Leaf number, LA= Leaf area, SG= Stem girth, NOF= Number of fruits, FWT= Fruit weight, DM= Days to maturity, FRWT= Fresh weight, SL= Shelf-life

(26.0), this showed a 35% reduction from the highest yield genotype. The LSD of 12.0 suggests high variability existed. Boomerang F₁ produced had the fruits (91.6 g), while Cirea the least fruit weight (57.76 g).

For days to Days to Maturity, Cirea has the longest days to maturity date (100 days), while Mona F₁ and Boomerang F₁ matured have the earlier days to maturity (76-79 days) respectively. Fruit Girth, Boomerang F₁ had largest fruit diameter (15.4 cm), while Cirea was the smallest (10.0 cm). The result of Shelf Life (SL) showed that, Riograde (+) has longer shelf life (17.67 days), while Cirea had the shortest SL (8.33 days). This showed that the 112% difference is important for post-harvest management. The differences between Boomerang F₁ (high leaf number, heavy fruits) and Cirea (low leaf number, light fruits, long maturity) suggest these genotypes represent distinct genetic pools desirable for breeding programs. Chabbi *et al.* (2018) reported that there are highly significant differences among genotypes for all the traits plant height (LSD 20.86) and Leaf Number (LSD 22.2). They also reported that there is high heritability for number of fruits per plant and plant height. The study also revealed that there is a significant genotypic difference exist for all traits in the study accessions and Boomerang F₁ and Mona F₁ are superior for yield, and Riogrande+ for shelf life, while Cirea existed as an outlier accession. The differences in vegetative traits suggest that the genotypes vary in their capacity for resource acquisition and utilization. Genotypes exhibiting superior vegetative growth may possess greater photosynthetic potential, enabling them to accumulate

more assimilates for reproductive development. However, vigorous vegetative growth does not necessarily guarantee higher yield, as the partitioning of assimilates between vegetative and reproductive organs is under genetic control. Similar findings were reported by Prigigallo *et al.* (2025), who observed that morphological and physiological differences among tomato genotypes influence biomass accumulation and resource allocation patterns. Similarly, Beckles (2012), affirmed that yield performance in tomato depends not only on photosynthetic capacity but also on the efficiency of assimilate translocation and partitioning towards developing fruits. Therefore, genotypes with vigorous vegetative growth may not necessarily achieve the highest fruit yield if assimilate allocation favors vegetative structures over reproductive sinks. The observed variation in fruit-related traits is particularly important because these characteristics directly influence market value and consumer preference. Fruit size, fruit weight, and fruit number are primary determinants of economic yield in tomato production. Significant differences among genotypes for these traits indicate the presence of exploitable genetic variability, which provides opportunities for effective selection and genetic improvement. Similar observations were reported by Salim *et al.*, (2020), reported that substantial variation among tomato genotypes for fruit yield and yield-contributing traits, highlighting their importance in varietal improvement.

The mean performance result (Table 2.) showed the Plant height for the five genotypes; Mona F₁ (105.2a), Riogrande+ (115.3a), Boomerang F₁ (116.7a), and

Cirea (114.0a) which forms one statistically similar group, while Topaze (88.0^b) is significantly shorter. The CV of 11.10% indicated moderate experimental precision. For Number of Branches, Mona F₁ (14.4^a) had the highest NOB, while Cirea (12.0^b) lags significantly, while others genotypes are intermediate and statistically similar (13.4-13.6^{ab}). Boomerang F₁ (80.9^a) produces significantly more leaves than all others. Topaze (73.5^{ab}) showed an intermediate leaf

number, while Cirea had the lower number of leaves (28.8^c), this may be as a result of the genetic difference in growth habit of the tomato genotypes. Leaf Area mean performance shows that, Mona F₁ (39.77^a) and Boomerang F₁ (37.6^a) have largest leaves, statistically similar. Topaze (30.57^b), Riogrande+ (32.0^b), and Cirea (32.3^b) form smaller-leaf group.

Table 2: Mean Performance for Agronomic Traits of Tomato genotypes

GENOTYPE	PHT	NOB	LN	LA	SG	NOF	FWT	DM	FR	SL
Mona F ₁	105.2a	14.4a	59.3b	39.77a	1.43c	40.0a	75.0c	76.0c	12.73b	14.0b
Topaze	88.0b	13.4ab	73.5ab	30.57b	1.85a	26.0b	80.7b	81.0c	13.79b	12.bc
Riogrande +	115.3a	13.4ab	61.8b	32.0b	1.72b	37.0a	70.2c	92.0b	13.3b	17.67a
Boomerang F ₁	116.7a	13.6ab	80.9a	37.6a	1.60bc	30.0bc	91.6a	79.0c	15.4a	14.0b
Cirea	114.0	12.0b	28.8c	32.3c	1.53c	36.0c	57.76d	100.0a	10.0cb	8.33c
Mean	107.84	13.36	60.86	34.4b	1.63	33.8	75.05	85.6	13.04bc	13.2
CV (%)	11.10	6.48	32.8	11.6	10.6	16.8	16.7	11.8	15.1a	25.8

CV = Cumulative value. PHT= Plant height, NOB= Number of branches, LN= Leaf number, LA= Leaf area, SG= Stem girth, NOF= Number of fruits, FWT= Fruit weight, DM= Days to maturity, FRWT= Fresh weight, SL= Shelf-life

For Stem Girth Topaze (1.85a) has thickest stems, significantly different from all others, while Mona F₁ (1.43^c) and Cirea (1.53^c) have thinnest stems. Number of Fruits; Mona F₁ (40.0^a) and Riogrande+ (37.0a) are top yielders and are statistical similar. Boomerang F₁ (30.0^{bc}) and Cirea (36.0^a) show intermediate production, while Topaze (26.0^b) produces significantly fewer fruits. For Fruit Weight, Boomerang F₁ (91.6^a) produces heaviest fruits significantly heavier than all others, followed by Topaze (80.7^b), Mona F₁ (75.0^c) and Riogrande+ (70.2^c) which produce lighter fruits, while Cirea (57.8^d) produces lightest fruits of all the five-genotype studied. Days to Maturity shows that Cirea (100.0^a) matures significantly later than all others (15-24 days later), Riogrande+ (92.0^b) is intermediate, Mona F₁ (76.0c), Topaze (81.0c), and Boomerang F₁ (79.0^c) are early-maturing genotypes. Fruit Girth, shows that Boomerang F₁ (15.4^a) produces largest-diameter fruits, followed by Mona F₁ (12.73b), Topaze (13.79b), Riogrande+ (13.3^b), and Cirea (10.0^{cb}) form the lower group. For Shelf life, Riogrande+ (17.67a) had longest shelf life and is

significantly longer than all others (p<0.05). Mona F₁ (14.0^b) and Boomerang F₁ (14.0^b) are intermediate, while Topaze (12.0^{bc}) and Cirea (8.33^c) have shortest shelf lives. Mean separation confirms the various distinct groups existing within the accessions with high CV for leaf number and shelf life indicating strong genetic control. High heritability, combined with high genetic advance observed for fruits per plant, and fruit weight revealed that these traits are controlled by additive gene action rather than dominant gene. The mean performance analysis provides insight into the comparative strengths and weaknesses of each genotype and revealed distinct patterns of adaptation and productivity. Evaluation of genotype mean performance is an important approach for identifying superior accessions and understanding the extent of phenotypic variation among genotypes under specific environmental conditions. This affirmed the observations reported by Salim *et al.* (2020), who found that means performance analysis effectively differentiated tomato genotypes based on growth, yield, and morphological characteristics, thereby facilitating the identification of promising

genotypes for breeding and cultivation. Similarly, Fagbemi *et al.* (2021) reported that phenotypic characterization enables the assessment of genotype adaptation and productivity potential, providing useful information for varietal improvement programmes. The grouping pattern observed in the mean separation further indicated that certain accessions may share similar genetic characteristics, while others are genetically divergent. Genetically divergent parents are often preferred in hybridization programmes because they increase the probability of generating superior segregating populations and exploiting heterosis through the recombination of favorable alleles. This observation corresponds to the

findings by Bai and Lindhout (2007), who reported that the utilization of genetically diverse parental lines enhances the probability of obtaining superior hybrids and broadens the genetic base available for selection. Similarly, Acquah (2007) noted that crosses involving genetically divergent parents generally produce greater variability in segregating generations, thereby increasing opportunities for selection and genetic gain. Furthermore, Salim *et al.* (2020) also revealed that phenotypic divergence among tomato genotypes provides useful information for identifying potential parents for hybridization and crop improvement programmes.

Table 3: Correlation Matrix between the phenotypic traits

Traits	PHT	NOB	LN	LA	SG	NOF	FRWT	DM	FG	SL
PHT	-									
NOB	0.258	-								
LN	0.22	0.502*	-							
LA	0.363	0.024	0.103	-						
SG	-0.451	-0.591*	0.405	-0.251	-					
NOF	0.516*	0.518*	0.132	0.036	0.433	-				
FRWT	0.021	0.154	0.519*	0.075	0.395	0.559*	-			
DM	0.083	-0.123	-0.138	-0.118	-0.22	0.569*	0.743**	-		
FG	-0.097	0.228	0.229	0.295	0.053	0.666**	0.715**	0.868**	-	
SL	0.003	0.207	0.267	-0.021	0.146	-0.313	0.743**	0.694**	0.634*	-

* = significant at $p < 0.05$, ** = significant at $p < 0.01$ PHT= Plant height, NOB= Number of branches, LN= Leaf number, LA= Leaf area, SG= Stem girth, NOF= Number of fruits, FWT= Fruit weight, DM= Days to maturity, FRWT= Fresh weight, SL= Shelf-life

The result of correlation (Table 3) shows that two correlations occurred on the matrix; strong positive correlations and Negative correlation. For strong positive correlation, Fruit Weight $\times$ Shelf Life (0.743**) shows strong correlation and are significant at $p < 0.01$, suggesting that heavier fruits last longer after harvest and is of commercial value as selection of larger fruits simultaneously improves post-harvest longevity. Fruit Weight and Fruit Girth (0.715**), shows strong correlation with larger diameter and

fruits weigh. Fruit Girth and Number of Fruits (0.666**) shows a positive correlation as wider fruits associated with higher fruit count. Fruit Girth $\times$ Shelf Life (0.634*) correlation shows that wider fruits also last longer. Days to Maturity $\times$ Number of Fruits (0.569*) correlation shows that late maturing plants produce more fruits. Number of Branches and Number of Leaves (0.502*) correlation reveals that, more branches is directly proportional leaves. Strong Negative Correlations matrix result reveals that, Days

to Maturity and Fruit Weight (-0.743**) a negative association indicating late maturing plants produce lighter fruits. Days to Maturity and Fruit Girth (-0.868**), strongest negative correlation in the table, suggesting that late maturation is strongly associated with smaller fruit diameter. Days to Maturity and Shelf Life (-0.694**) showed negative association suggesting that, late maturing fruits have shorter shelf life, while Fruit Weight and Number of Fruits (-0.559*) shows a weak but significant plants with more fruits tend toward smaller individual fruits. On the matrix Plant height shows no significant correlation with any trait except number of fruits (0.516*), Stem girth and number of fruits (0.433) approaches significance but doesn't reach $p < 0.05$, while Leaf area shows no significant correlations. Fruit weight and Shelf life are positively correlated ($r = 0.743^{**}$). The correlation analysis provides important information regarding the relationships among traits and helps breeders identify indirect selection criteria for crop improvement. Understanding the association among agronomic traits enables breeders to select for complex characteristics through correlated traits that are easier to measure or possess higher heritability. Similar findings were reported by Thapa *et al.* (2022), who noted that correlation analysis is an effective tool for identifying traits that contribute directly or indirectly to yield improvement in tomato. Adedugba *et al.* (2023) also reported that correlation studies provide valuable information on the nature and magnitude of relationships among traits and assist breeders in formulating efficient selection strategies. The study also showed there was high heritability for fruits per plant (99.61%) and single fruit weight (99.06%) with heritability. This is in agreement with the findings of Bangladesh Journal of Bioscience and Related Sciences (2025). Similarly, the negative correlations observed between days to maturity and shelf life ($r = -0.694^{**}$) may be attributed to environmental influenced. This is in line with the work of Frontiers in Sustainable Food Systems (2022) finding that fruit weight and shelf life are positively correlated ($r = 0.743^{**}$). This study also confirmed a high heritability for fruits per plant (99.61%) and single

fruit weight (99.06%), which is in accordance with the findings of Bangladesh Journal of Bioscience and Related Sciences (2025), also reported that coefficient analyses for fruit diameter, number of secondary branches, single-fruit weight, and skin thickness are positively associated with fruit yield. Also fruit weight, fruit girth, and shelf life are positively correlated days to maturity but negatively correlated with fruit size and shelf life. From a breeding standpoint, the correlation analysis identifies fruit weight, fruit girth, and shelf life as strategic selection traits because the positive associations among these characters suggest that improvement in one trait may lead to corresponding gains in the others. Such favorable relationships are particularly useful in breeding programmes because they enhance the efficiency of indirect selection for yield and quality improvement. Similar findings have been reported in tomato, where fruit weight and fruit size traits exhibited strong positive correlations with economically important characteristics and were recommended as reliable selection indices Reddy *et al.* (2013); Thapa *et al.* (2022). In contrast, the negative association observed between maturity period and several fruit characteristics indicated that prolonged maturity may adversely affect fruit performance, necessitating careful consideration of maturity traits during selection to avoid unfavorable correlated responses.

Conclusion

The mean performance vividly differentiated the five genotypes into distinct groups, as Boomerang F₁ showed superiority for fruit weight and fruit girth, Mona F₁ performed well in fruit number, early maturity, and leaf area, Riogrande + was outstanding for shelf life and high fruit count, Topaze has thick stems but lower in fruit yield, while Cirea is genetically different with late maturity, small fruits, and short shelf life, which makes it a good genetic genotype for breeding programs. Analysis of variance confirmed significant genotypic differences among the five tomato genotypes for all agronomic traits assessed. Varying ranges observed from plant height, leaf number, fruit weight, fruit girth, and shelf life, revealed the substantial genetic diversity within the studied cultivars. Boomerang F₁ reveals the superior

vegetative growth in leaves and fruit size, while Mona F₁ performed well in fruit number and early maturity, also Riogrande+ showed exceptional post-harvest shelf life, and Cirea remained genetically different with late maturity and small fruits. The correlation matrix confirms that fruit weight, fruit size, and shelf life can be improved upon simultaneously, as these traits are positively associated. However, it is essential for breeders to pay close attention to days to maturity, because prolonged maturity tends reduce fruit size, weight, and storage life of the tomato plant.

Recommendation

Riogrande + is recommend to be utilized as parent for shelf-life improvement due to outstanding trait useful for addressing post-harvest losses. Mona F₁ genotypes

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