

Original Research Article

Comprehensive assessment of genetic variability and trait Associations governing processing quality in tomato

ABSTRACT

Aim: To assess genetic variability, heritability, and genetic advance for key yield and processing-related fruit quality traits in tomato, along with the association patterns among these traits, was investigated through correlation studies.

Study design: Randomized complete block design with two replications

Place and Duration of Study: At the College of Agriculture, Navile, Shivamogga, during summer 2024.

Methodology: Twenty tomato genotypes were evaluated for yield and fruit quality traits relevant to processing.

Results: Analysis of variance showed significant differences among tomato genotypes for all traits, indicating substantial variability in growth, yield and quality attributes. High genetic variability, heritability, and genetic advance for ascorbic acid, lycopene, ripening index, pericarp thickness, fruit firmness, fruit weight, and locule number. In contrast, plant height and fruit yield showed moderate heritability, influenced more by environmental factors. Quality traits such as total soluble solids, titratable acidity, and pH exhibited high heritability but moderate genetic advance, suggesting potential for gradual improvement. Correlation analysis revealed strong positive relationships among key yield traits. Days to fifty per cent flowering correlated with days to maturity, plant height, total soluble solids, ripening index, and fruit number. Fruit weight and diameter were negatively correlated with flowering time but positively associated with yield and cluster size. Processing quality traits were interconnected: total soluble solids strongly correlated with lycopene and ripening index but negatively with titratable acidity, pH, and fruit size. Lycopene content was inversely related to ascorbic acid, pulp recovery, and locule number. Ascorbic acid was positively correlated with fruit pH but negatively with fruit count, whereas pericarp thickness increased firmness, pulp recovery, and fruit weight but reduced ripening rate and fruit number.

Conclusion: Study of genetic parameters describing variability revealed the potential for gradual improvement. Correlation results highlight key trade-offs between yield and quality traits crucial for breeding processing-oriented tomato genotypes.

Keywords: Variability, Correlation, Processing, Fruit quality, Fruit yield

1. INTRODUCTION:

Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated vegetable crops worldwide and a cornerstone of the processing industry due to its economic and nutritional importance. Processed tomato products, including puree, paste, ketchup, sauces, and canned items, require raw materials with specific fruit quality attributes such as high total soluble solids (TSS), elevated lycopene content, firm pericarp, desirable acidity and uniform fruit size. These traits directly affect processing efficiency, product consistency and consumer acceptance (Figueiredo *et al.*, 2015). At the same time, sustainable yield improvement remains a key goal to meet the increasing demand of the processing sector. However, genetic improvement of tomato for processing suitability is limited by the lack of detailed information on the extent of inherent variability and the interactions among key quality and yield traits (Rodriguez *et al.*, 2010).

تعليق عليه [Future1]: 1. The introduction highlights the importance of yield and quality traits in tomato but does not clearly define the specific knowledge gap that the study aims to address. The problem within current tomato breeding programs and why existing information on genetic variability and trait associations is insufficient is not explicitly stated. Clearly identifying the research gap strengthens the rationale of the study.

2. Although the introduction provides a sound description of genetic variability, heritability, and genetic advance, it lacks strong support from updated and recent literature. Most of the cited references are relatively old (2010–2015), and the text does not incorporate newer studies that reflect the latest advances in genetic variability analysis or modern breeding techniques in tomato. This weakens the contemporary scientific relevance of the introduction.

Understanding the magnitude of genetic variability is fundamental for the identification of superior genotypes and for predicting the potential of selection. Traits such as TSS (total soluble solids), lycopene, ascorbic acid, fruit firmness, and titratable acidity exhibit substantial variation across germplasm, populations, and hybrids, but their responsiveness to selection depends on genetic parameters such as genotypic and phenotypic coefficients of variation (GCV and PCV), heritability and genetic advance. Estimating these parameters provides insights into the relative contribution of genetic and environmental components to trait expression, thereby guiding breeders in selecting traits that are both highly heritable and amenable to improvement. Yield traits such as number of fruits per plant, number of clusters, fruit weight and fruit size also vary widely and require robust quantification to identify promising breeding lines.

Correlation and association analyses further enhance the understanding of trait interdependencies, which is crucial when multiple traits are targeted simultaneously. In processing tomatoes, fruit quality traits often exhibit complex relationships with yield components, and improving one trait may positively or negatively influence others. Genotypic and phenotypic correlation coefficients, along with path coefficient analysis, help to unravel direct and indirect effects of quality traits on yield and vice versa. Such insights enable breeders to identify key drivers of processing suitability and yield and to develop selection indices that integrate multiple desirable attributes.

In this context, the present study aims to quantify the genetic variability, heritability, and genetic advance for key yield and processing-related fruit quality traits in tomato, and to elucidate the association patterns among these traits. By characterizing trait variability and inter-trait relationships in a diverse set of tomato genotypes, the study provides a scientific basis for developing breeding strategies that combine high yield potential with superior processing quality. The outcomes will contribute to the identification of promising genotypes and critical traits that can be targeted in future hybridization and selection programs to enhance tomato processing efficiency and product quality.

2. MATERIAL AND METHODS

The experimental material for this study consisted of 20 tomato genotypes collected from various sources and evaluated for fruit quality and yield characters during the summer 2024 at the College of Agriculture, Navile, Shivamogga. Recommended crop production and protection, a package of practices was followed to raise a healthy crop. Initially, tomato seeds were sown in the trays and twenty-six days (summer) old seedlings were transplanted in the main field at a spacing of 90 cm × 45 cm, accommodating a plant population of 10 per row as per randomized block design (RCBD) with two replications.

Observations on each entry were recorded on five randomly selected plants in each replication for fruit quality and yield characters. The average values were computed as genotype means under each replication. Fruit quality characters were recorded at the red ripe stage of tomato fruits. The total soluble solids were measured as the mean Brix value using an Erma hand refractometer in the fresh juice. The pH of the five tomato fruit juice samples was recorded using a Siemens pH meter. As paste is most preferred in processing industries, lycopene content (mg/100 g) was analysed using tomato paste by the spectrophotometric method by hexane: acetone: ethanol (2:1:1 v/v/v) (Anthon and Barrett, 2006). The percentage of acidity was determined by the titration method (AOAC, 942.15). Ascorbic acid (Vitamin C) (mg/100g) was measured using a titrimetric method using oxalic acid and 2,6-dichlorophenol indophenol (DCPIP) dye solution (AOAC, 967.21). Ripening index for each genotype was computed as the ratio of total soluble solids (Brix) to titratable acidity (%).

Fruit morpho-physiological characters were recorded at the red ripe stage of tomato fruits. The average fruit length in centimetres of the five randomly selected fruits of each of the five plants from each genotype was measured from the stem end to blossom end after cutting the fruit vertically using a digital vernier calliper. Whereas fruit width (cm) measured as the mean equatorial diameter in

Future2]: 1. The experiment used a Randomized Complete Block Design (RCBD) with only two replications, which is statistically insufficient for evaluating 20 tomato genotypes and a large number of studied traits (more than 25 traits). The low number of replications reduces statistical precision, increases experimental error, and weakens the reliability of GCV, PCV, and heritability estimates.

2. Although many measurement procedures were described in detail, the methodology lacks essential environmental and standardization information, such as:

- Laboratory temperature and measurement conditions for TSS, pH, lycopene,
- A clearer and more objective fruit maturity index (instead of the general "red ripe stage"),
- Conducting the experiment in a single season, which prevents proper separation of genetic and environmental effects.

centimetres of five randomly selected fruits of each of five plants from each genotype, was measured at the maximum perimeter. The ratio of fruit length to fruit width was considered as fruit shape index. Fruit firmness (kg/cm^2) was measured as the mean pressure required for puncturing red ripe fruits near the stem and blossom ends in five randomly selected fruits of each of five plants from each genotype using a fruit penetrometer. Pericarp thickness (mm) was measured as the average thickness of the pericarp in millimetres in the transversely cut fruits using a digital vernier calliper for five randomly selected fruits of each of five plants from each genotype. Pulp recovery (%) was measured as the average pulp *per cent* content as a ratio of the weight of pulp to the total fruit weight. The number of locules in tomatoes was counted after cutting the fruit transversely from the middle portion. The mean locule number of five fruits was computed.

Earliness characters, such as days to fifty per cent flowering, was the total number of days required for fifty per cent of the population of each genotype for the opening of flowers from the date of transplanting. Days to maturity was the total number of days taken by each genotype from the date of transplanting to the fruit achieving the breaker stage (colour change from green to yellow/pink) was observed and recorded. Growth characters, such as plant height, was measured in centimetres from the base of the plant (ground level) to the tip of the plant at the time of physiological maturity.

Fruit yield characters were recorded at the final harvest of tomato fruits. Number of fruits per cluster measured as the total number of fruits per cluster on each plant was counted and recorded for each genotype. The mean number of fruits per cluster of five plants was computed. The total number of fruits per plant was counted and recorded for each genotype. The mean number of fruits per plant of five plants was computed. Fresh weight of fruits per plant was recorded for each genotype per replication at various pickings and the mean was calculated and expressed in kilograms per plant. The mean yield per plant of five plants was computed.

The data of mean value for all the characters were analysed for their variance following the Randomized Complete Block Design outlined as given by Cochran and Cox (1957). All descriptive statistics were computed using the 'TraitStats' package in the R software environment (R Core Team, 2025). Mean, range, the phenotypic coefficients of variability (PCV) and genotypic coefficients of variability (GCV) for all the characters were computed (Burton and De Vane, 1953) and expressed as per cent. PCV and GCV values were further categorised as indicated by Sivasubramanian and Madavamenon (1973) as low (0-10%), moderate (10.1-20%) and high (above 20%). Heritability in a broad sense for all characters was estimated as the ratio of genotypic variance to the phenotypic variance and is expressed in *per cent* (Hanson *et al.*, 1956). The heritability was categorised as low (0-30%), moderate (30.1 – 60%) and high (above 60%) as per Robinson *et al.* (1949). The expected GAM is estimated as a ratio of genetic advance to mean expressed in per cent. The GAM was categorised as low (0-10%), moderate (10.1-20 %) and high (above 20 %) as per Johnson *et al.* (1955)

The correlation coefficients were calculated to determine the degree of association of prominent fruit quality and yield contributing traits. Phenotypic coefficients of correlation between all pairs of characters were determined by using variance and covariance components as suggested by Al-Jibouri *et al.* (1958). The analysis was done by using the R software version 4.1 ('metan' package).

3. RESULTS AND DISCUSSION

3.1 Analysis of variance for fruit quality and yield attributes in tomato genotypes

Analysis of variance showed significant differences among the tomato genotypes for all twenty traits, demonstrating substantial variability among the genotypes (Table 1). These results are consistent with those reported by Jogi *et al.* (2023) and Kharat *et al.* (2022).

3.2 Genetic variability parameters

Future3] تعليق عليه: 1. The section presents extensive values of correlations and genetic parameters but lacks sufficient biological or genetic interpretation supported by literature, making several parts more descriptive rather than analytical.

2. Although numerous numerical parameters were reported (GCV, PCV, heritability, and genetic advance), no supporting analyses such as path analysis or PCA were used to explain the complex relationships among traits, which weakens the conclusions regarding how the traits influence one another.

3. The discussion relies heavily on comparisons with previous studies without analyzing the causes of agreement or disagreement, and it does not clearly connect the findings to breeding programs or field-level applications, reducing the practical relevance of the results despite the richness of numerical data.

The results of parameters specifying genetic variability are presented in Table 3. Information on the heritable portion of variability is more important than the total variability for crop improvement. The mere variability estimates will not provide the real picture of the heritable fraction of variability. Therefore, variability regarding genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) becomes imperative. The observed variation among the genotypes could be due to genetic differences and environmental causes. Heritability measures the proportion of observed variation among plants that is due to genetic differences. The primary purpose of estimating heritability is to compare the expected gain from the selection with alternative selection strategies.

Genetic variability parameters such as the genotypic coefficient of variation, phenotypic coefficient of variation, broad sense heritability and genetic advance as a percentage of the mean (GAM) are estimated for eighteen quantitative characters in thirty tomato germplasm lines and the results are presented in Table 2.

Days to fifty *per cent* flowering recorded moderate GCV (17.27%) and PCV (17.65%) with high heritability (95.73%) and moderate GAM (34.81%). Similarly, days to maturity showed moderate GCV (12.26%) and PCV (12.43%) with high heritability (97.33%) and moderate GAM (24.92%). Plant height exhibited moderate GCV (16.43%) and high PCV (20.14%) with moderate heritability (66.51%) and moderate GAM (27.60%).

Fruit quality defining traits, such as total soluble solids, showed moderate GCV (15.50%) and PCV (16.25%) with high heritability (91.01%) and moderate GAM (30.46%). Lycopene content recorded moderate GCV (19.25%) and high PCV (20.61%) with high heritability (87.19%) and high GAM (37.02%). Whereas ascorbic acid content showed high GCV (34.41%) and PCV (35.31%) with high heritability (94.94%) and very high GAM (69.06%). pH recorded moderate GCV (12.28%) and PCV (13.17%) with high heritability (86.88%) and moderate GAM (23.57%). Titratable acidity showed high GCV (24.09%) and PCV (24.48%) with high heritability (96.85%) and high GAM (48.84%). Ripening index exhibited high GCV (40.22%) and PCV (40.68%) with high heritability (97.76%) and very high GAM (81.93%). Fruit firmness showed high GCV (26.80%) and PCV (29.42%) with high heritability (82.98%) and high GAM (50.29%). Fruit length showed high GCV (24.41%) and PCV (24.64%) with high heritability (98.13%) and high GAM (49.82%). Fruit diameter exhibited high GCV (20.97%) and PCV (21.41%) with high heritability (95.94%) and high GAM (42.32%). While fruit shape index recorded high GCV (29.99%) and PCV (30.39%) with high heritability (97.42%) and high GAM (60.98%). Number of locules per fruit showed high GCV (29.84%) and PCV (30.33%) with high heritability (96.80%) and high GAM (60.48%).

Yield-governing characters, such as pericarp thickness, exhibited high GCV (21.37%) and PCV (22.73%) with high heritability (96.68%) and high GAM (43.29%). Pulp recovery exhibited moderate GCV (12.16%) and PCV (13.67%) with high heritability (79.10%) and high GAM (22.29%). Number of fruits per plant exhibited high GCV (23.63%) and PCV (25.02%) with high heritability (89.21%) and high GAM (45.98%). The number of fruits per cluster recorded moderate GCV (17.60%) and PCV (19.29%) with high heritability (83.21%) and moderate GAM (33.07%). Fruit weight exhibited high GCV (28.22%) and PCV (29.88%) with high heritability (89.23%) and high GAM (54.92%). While fruit yield per plant recorded high GCV (20.85%) and PCV (27.19%) with moderate heritability (58.80%) and moderate GAM (32.94%).

The present investigation revealed considerable variability among the evaluated tomato genotypes for growth, yield and quality traits, as evidenced by the ranges of GCV, PCV, heritability and genetic advance as a percentage of the mean. Traits such as ascorbic acid, lycopene content, ripening index, pericarp thickness, fruit firmness, fruit weight and number of locules per fruit recorded high GCV and PCV coupled with high heritability and high GAM, indicating the predominance of additive gene action and scope for effective selection. Similar results were reported earlier, where high heritability and genetic advance were observed for fruit weight, lycopene and ascorbic acid in tomato. Conversely, traits

like plant height and fruit yield per plant exhibited relatively larger differences between GCV and PCV with moderate heritability, suggesting greater environmental influence.

Quality traits, including TSS, titratable acidity and pH, displayed high heritability with moderate GAM, suggesting that while these are stable traits, genetic improvement will be gradual. Importantly, the ripening index exhibited very high GCV, PCV, heritability and GAM, making it a promising selection target for developing processing types. Overall, the predominance of high heritability coupled with high genetic advance in several quality and yield-contributing traits indicates that selection will be effective in improving both productivity and processing quality. Similar findings were reported by Meena *et al.* (2015), Ravindra *et al.* (2015) and Amarjeet *et al.* (2016).

3.3 Correlation coefficients among fruit quality and yield attributes of tomato genotypes

The findings of this analysis are illustrated in Fig. 1, providing insights into the nature of trait associations. Days to fifty *per cent* flowering showed significant positive correlations with days to maturity (0.89), plant height (0.77) and total soluble solids (0.59). Positive correlations were also observed between days to fifty *per cent* flowering and ripening index (0.61) and number of fruits per plant (0.46). Significant negative correlations existed between days to fifty *per cent* flowering and fruit pH (-0.61), titratable acidity (-0.48), fruit diameter (-0.46) and fruit weight (-0.48).

Days to maturity showed strong positive correlations with plant height (0.74), total soluble solids (0.50), ripening index (0.46) and the number of fruits per plant (0.51). Also observed significant negative correlations with fruit pH (-0.46), pericarp thickness (-0.49), pulp recovery (-0.54), fruit firmness (-0.48) and fruit diameter (-0.48). Plant height expressed a significant positive correlation with total soluble solids (0.63), lycopene content (0.61), ripening index (0.54) and number of fruits per plant (0.54). Also showed significant negative correlations with pericarp thickness (-0.46), pH (-0.48), pulp recovery (-0.57) and number of locules per plant (-0.49).

Total soluble solids, a key trait for processing quality, showed significant positive correlations with lycopene (0.73), ripening index (0.87) and number of fruits per plant (0.70). Also showed significant negative correlations with titratable acidity (-0.54), pH (-0.56), fruit diameter (-0.51) and fruit weight (-0.46). Lycopene content was positively associated with ripening index (0.57) and the number of fruits per plant (0.75). Significant negative correlations of lycopene were observed with ascorbic acid (-0.48), pH (-0.46), pulp recovery (-0.50), number of locules per fruit (-0.64) and fruit diameter (-0.58).

Ascorbic acid was positively correlated with fruit pH (0.51) and negatively associated with the number of fruits per plant (-0.57). Pericarp thickness demonstrated strong positive correlations with pulp recovery (0.78), fruit firmness (0.72), fruit length (0.59), fruit diameter (0.61), fruit weight (0.87) and fruit yield per plant (0.67). However, pericarp thickness was negatively associated with ripening index (-0.54) and the number of fruits per plant (-0.52). The fruit pH was positively correlated with titratable acidity (0.40) and was negatively associated with ripening index (-0.55) and the number of fruits per plant (-0.63). Similarly, titratable acidity showed a significant negative correlation with ripening index (-0.82). Ripening index was negatively correlated with pulp recovery (-0.48), fruit diameter (-0.56), fruit weight (-0.63), fruit yield per plant (-0.50) and number of fruits per plant (0.62).

Pulp recovery was positively correlated with fruit firmness (0.63), fruit length (0.71), fruit diameter (0.48), fruit weight (0.63) and fruit yield per plant (0.54). However, it showed a strong negative correlation with the number of fruits per plant (-0.66). Fruit firmness revealed significant positive correlations with fruit length (0.73), fruit weight (0.58) and fruit yield per plant (0.48). The number of locules per fruit exhibited a significant negative correlation with fruit shape index (-0.53). Fruit length was highly correlated with fruit shape index (0.74). In contrast, fruit diameter exhibited a significant negative correlation with fruit shape index (-0.52). Fruit weight showed a significant positive correlation with fruit yield per plant (0.81).

The yield-related traits exhibited notable interrelationships that are crucial for improving tomato production. Days to fifty *per cent* flowering and days to maturity showed strong positive correlations with plant height and the number of fruits per plant, indicating that genotypes with longer growth durations tend to be taller and produce more fruits. Fruit weight demonstrated a significant positive correlation with fruit yield per plant and the number of fruits per cluster, emphasizing its role as a key yield component. However, traits like pericarp thickness and pulp recovery, which were positively associated with fruit firmness and size parameters, displayed negative correlations with the number of fruits per plant, highlighting an agnostic relationship between fruit quality and fruit yield. These interactions suggest that breeding for higher yield in processing tomatoes must consider complex compensations between fruit number, size, and structural traits to optimize overall productivity.

In contrast, processing-related traits revealed a complex network of biochemical and morphological associations essential for fruit quality. Total soluble solids (TSS), a critical determinant of processing quality, correlated positively with lycopene content, ripening index, and number of fruits per plant, but negatively with titratable acidity, pH, fruit diameter, and weight. Lycopene content was positively linked to ripening index but negatively associated with ascorbic acid, pH, pulp recovery, and fruit size measures, indicating an intricate inverse relationship between nutritional and physical fruit qualities. Pericarp thickness strongly influenced pulp recovery, firmness, and various size traits, confirming its importance for processing texture and yield. Meanwhile, acidity and pH relationships underscored their role in flavour and ripening dynamics, with higher acidity negatively correlated with ripening index and fruit number. These insights highlight the need to balance sugar-acidity levels, nutritional content, and fruit morphology for developing tomatoes suited for processing industries.

These findings align with existing literature that underscores fruit size, firmness, and pulp content as integral to processing quality. These results were strongly corroborated by Arya *et al.* (2023), Badge *et al.* (2021), Kumar *et al.* (2023), Rasheed *et al.* (2023) and Zannat *et al.* (2023).

4. CONCLUSION

The current study resulted that fruit quality traits such as total soluble solids, titratable acidity and pH exhibited high heritability with genetic advance, making them feasible for genetic improvement. The identified trait associations among fruit weight, soluble solids, ripening index, lycopene, pericarp thickness, and pulp recovery are foundational for breeding tomatoes with superior processing qualities.

تعليق عليه [Future4]: 1. Although the conclusion highlights the potential for improving certain traits genetically, it does not explain how these findings can be directly utilized in breeding programs or outline specific breeding strategies based on the high-heritability traits. This limits the practical value of the conclusion.

2. The conclusion does not address traits with large differences between GCV and PCV or those with moderate heritability, nor does it clarify why these traits are less suitable for selection or how they should be handled in improvement programs. This makes the conclusion less comprehensive relative to the presented results.

Table 1: Analysis of variance for yield and fruit quality traits in tomato genotypes during summer 2024.

Source of variation	Mean sum of squares										
	Degrees of freedom	Total soluble solids (°Brix)	Lycopene (mg/100g)	Ascorbic acid (mg/100g)	Pericarp thickness (mm)	pH	Titrateable acidity (%)	Ripening index	Fruit length (cm)	Fruit diameter (cm)	Fruit shape index
Replication	1	0.10	0.16	4.08	0.13	0.02	0.01	1.44	0.09	0.01	0.004
Genotypes	19	1.07*	5.92*	70.37*	1.99*	0.66*	0.02*	40.45*	2.64*	1.98*	0.19*
Error	19	0.05	0.40	1.83	0.03	0.05	0.01	0.45	0.03	0.04	0.003
Source of variation	Mean sum of squares										
	Degrees of freedom	Pulp recovery (%)	Fruit firmness (kg/cm ²)	Number of locules per fruit	Days to fifty per cent flowering	Days to maturity	Plant height (cm)	Number of fruits per plant	Number of fruits per cluster	Fruit weight (g)	Fruit yield per plant (kg)
Replication	1	21.40	0.01	0.12	0.63	0.23	549.07	0.23	0.22	1.44	0.06
Genotypes	19	195.83*	0.47*	2.00*	103.38*	316.59*	713.65*	160.16*	1.62*	871.70*	0.40*
Error	19	22.84	1.73	0.03	2.26	4.28	143.52	9.13	0.14	49.61	0.10

* Significant at p<0.05

Table 2: Estimates of parameters specifying variability in tomato for yield and fruit quality traits during summer 2024

SL. No	Characters	Range		Mean	GCV (%)	PCV (%)	h ² _(bs)	GAM (%)
		Max.	Min.					
1	Days to fifty per cent flowering	57.00	32.00	41.18	17.27	17.65	95.73	34.81
2	Days to maturity	132.00	78.00	101.93	12.26	12.43	97.33	24.92
3	Plant height (cm)	155.43	69.55	102.77	16.43	20.14	66.51	27.60
4	Total soluble solids (°Brix)	7.28	3.69	4.61	15.50	16.25	91.01	30.46
5	Lycopene (mg/100g)	14.01	4.84	8.63	19.25	20.61	87.19	37.02
6	Ascorbic acid (mg/100g)	32.26	8.08	17.02	34.41	35.31	94.94	69.06
7	Pericarp thickness (mm)	6.06	1.24	4.63	21.37	22.73	96.68	43.29
8	pH	5.72	3.48	4.54	12.28	13.17	86.88	23.57
9	Titrateable acidity (%)	0.70	0.26	0.45	24.09	24.48	96.85	48.84
10	Ripening index	27.47	5.29	11.11	40.22	40.68	97.76	81.93
11	Pulp recovery (%)	89.10	39.22	76.44	12.16	13.67	79.10	22.29
12	Fruit length (cm)	8.15	1.99	4.69	24.41	24.64	98.13	49.82
13	Fruit diameter (cm)	6.51	2.07	4.70	20.97	21.41	95.94	42.32
14	Fruit shape index	1.93	0.71	1.03	29.99	30.39	97.42	60.98
15	Fruit firmness (kg/cm ²)	2.93	0.57	1.73	26.80	29.42	82.98	50.29
16	Number of fruits per plant	70.86	23.11	36.78	23.63	25.02	89.21	45.98
17	Number of fruits per cluster	6.56	3.16	4.88	17.60	19.29	83.21	33.07
18	Number of locules per fruit	6.00	2.00	3.33	29.84	30.33	96.80	60.48
19	Fruit weight (g)	102.58	6.12	71.83	28.22	29.88	89.23	54.92
20	Fruit yield per plant (kg)	2.98	0.65	1.86	20.85	27.19	58.80	32.94

Max. = Maximum

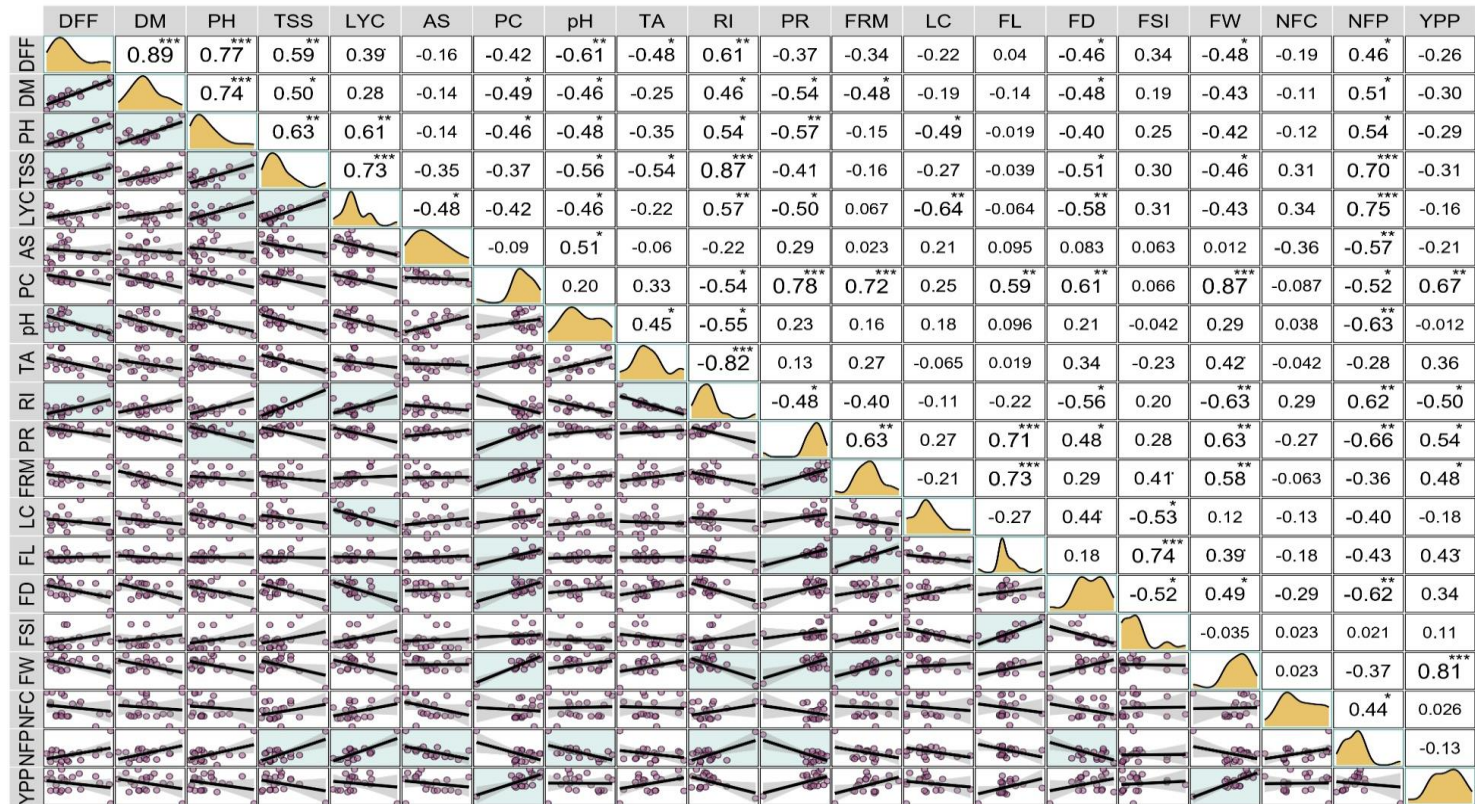
Min. = Minimum

h²_(bs) = Broad sense heritability

GCV = Genotypic co-efficient of variation

PCV = Phenotypic co-efficient of variation

GAM = Genetic advance as per of mean



DFF = Days to fifty per cent flowering, DM = Days to maturity, PH = Plant height (cm), TSS = Total soluble solids (°Brix), LYC = Lycopene (mg/100g), AS = Ascorbic acid (mg/100g), PC = Pericarp thickness (mm), pH = pH, TA = Titratable acidity (%), FL = Fruit length (cm), FD = Fruit diameter (cm), FS = Fruit shape index, RI = Ripening index, PR = Pulp recovery (%), FRM = Fruit firmness (kg/cm²), NFP = Number of fruits per plant, NFC = Number of fruits per cluster, LC = Number of locules per fruit, FW = Fruit weight (g), YPP = Fruit yield per plant (kg). Significance levels: *** = p<0.001, ** = p<0.01, * = p<0.05.

Fig 1: Pearson's correlation between fruit quality and yield attributes

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