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Evaluation and character association studies on yield and quality parameters of tamarind genotypes

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Abstract
The present investigation "Evaluation and character association studies on yield and quality parameters of tamarind genotypes" was carried out during 2017-18 at Forest Research Station (FRS), Govinkovi, Honnali taluk, Davangere district. The experiment was laid out in a randomized block design with three replications and 16 genotypes *viz.*, K-9, NTI-52, K-11, S-7, S-8, S-14, S-3, N-6, D-2, C-4, D-9, NTI-89, D-19, S-6, K-10 and K-12. While, the genotypes differed significantly with respect to total soluble solids (D-9: 22.76 $^{\circ}$Brix), titrable acidity (S-8: 11.25%) and sugars content *viz.*, reducing sugar (C-4: 34.06%), non-reducing sugar (D-9: 12.17%) and total sugar (C-4: 46.18%). The results of correlation co-efficient analysis revealed that pod length (cm), pod width (cm), pod weight (g), pulp weight (g), titrable acidity, total sugar, total soluble solids and pH attributes could be effectively used in tamarind improvement programme for selecting genotypes as they show positive association for higher yield.

Keywords: Correlation, quality, tamarind, yield

Introduction

Tamarind (*Tamarindus indica* L.) is a monotypic tree which belongs to the family Leguminosae (Fabaceae) and having the chromosome number 2n=24. It is a multipurpose tropical fruit tree used primarily for its fruits, which can either eaten fresh or processed. The name tamarind was derived from the Arabic word "Tamar-E-Hind" meaning "Date of India". It is cultivated throughout the tropics and sub-tropics of the world and has become naturalized in many places. In India, it is abundantly grown in Karnataka, Madhya Pradesh, Bihar, Chattisgarh, Andhra Pradesh and Tamil Nadu.

Almost every part of the tree are useful, but the most important is the fruit pulp. It is a rich source of vitamins, minerals and also contains more of calcium than any other fruit. Hence it has a potential commercial future for the preparation of soft drinks, jams and confectioneries. The pulp contains a small amount of carotene, thiamine and nicotinic acid. The ascorbic acid content in tamarind is in very small quantity (2 to 20 mg/100 g), moisture ranged from (20.15 to 24.50%), total soluble solids (18 to 48 ^{0}Brix), reducing sugars (25-45%), non-reducing sugar (16.52%), total sugar (35 to 50%) and organic acids (8-18%) and predominantly tartaric acid (Ishola *et al.*, 1990) [8]. The content of tartaric acid, however, does not decrease during fruit ripening, indicating that it is not utilized in fruit development; but during this time, reducing sugars increase to 30-40 percent giving the sour fruit a sweeter taste (El-Siddig *et al.*, 2006) [7]. Generally, the chemical constituents of the fresh ripe tamarind varieties varied depending on location, soil, climate and other agro-climatic conditions.

While, pod yield is a very complex economic character and it is outcome of association of number of factors inherent in plant, genetic linkage and the environment in which the plant is grown. In any tree improvement program, it is essential to know the association characters among the yield and quality related parameters for effectual selection. The study on evaluation and character association among yield and quality parameters of any fruit is of interest and value to the breeders and nutritionists. The marketability and acceptability of any fruits depends on its bio-chemical characters and composition.

Keeping above points in view, the present investigation "Evaluation and character association studies on yield and quality parameters of tamarind genotypes" was undertaken.

Material and methods

The present investigation entitled "Evaluation and character association studies on yield and quality parameters of tamarind genotypes" was carried out during 2017-18 at Forest Research Station (FRS), Govinkovi, Honnali taluk, Davangere district. The experiment was laid out in a randomized block design with three replications and 16 genotypes *viz.*, K-9, NTI-52, K-11, S-7, S-8, S-14, S-3, N-6, D-2, C-4, D-9, NTI-89, D-19, S-6, K-10 and K-12. The methods used for the estimation of various quality parameters of tamarind genotypes as given by Ranganna (1979) [13] are mentioned below.

Total soluble solids of tamarind pulp was recorded by using an ERMA Hand Refractometer (0-32 °Brix) and it was expressed as °Brix. The pH of the pulp was determined by using a digital u-365 pH meter. The titrimetric method was adopted for estimation of the ascorbic acid and it was expressed in (mg/100 g). The method described by Ranganna (1979) [13] was adopted for estimation of titrable acidity. Total sugar present in the tamarind pulp samples were estimated by Anthrone reagent method and it was expressed in percentage. Reducing sugar present in the tamarind pulp samples were estimated by DNSA (Dinitro salicylic acid) reagent method and it was expressed in percentage. Non-reducing sugar was calculated by deducting the quantity of reducing sugar from total sugar and multiplied by a constant factor 0.95 and the results expressed as percent of non - reducing sugar.

Simple correlation co-efficient analysis for yield and quality parameters was carried out employing the formula propounded by Al-jibouri *et al.* (1958) [3].

Results and Discussion

The genotypes differed significantly with respect to total soluble solids, titrable acidity, ascorbic acid, pH and sugars content (Table 1). The highest total soluble solids was recorded in D-9 (22.76 °Brix) and the least was recorded in S-6 (12.38 °Brix). This difference in total soluble solids content is due to the difference in sugar content of the pulp. The maximum titrable acidity content was recorded in S-8 (11.25%) while the minimum was recorded in C-4 (2.55%). This variation in acidity content is due to the difference in sugar content of the pulp and also inherent genetic makeup of each genotype. The maximum ascorbic acid content of pulp was recorded in K-10 (12.85 mg/100 g) and the minimum was recorded in S-7 (4.28 mg/100 g). The difference in the ascorbic acid content of pulp is due to the perpetual synthesis of glucose-6-phosphate throughout the growth and development of fruits which is thought to be the precursor of vitamin - C (ascorbic acid) and it also depends on the genotypic difference among the genotypes. The highest pH of the pulp was recorded in S-3 (3.41) and the lowest pH was recorded in S-8 (2.34). The difference in pH concentrate is attributed to the difference in acid to sugar ratio of the pulp and also a distinct feature of the different genotypes. Similar results were earlier reported by Adeola and Aworh (2012) [2].

The highest reducing sugar percent of the pulp was recorded in C-4 (34.06%) while, the lowest was recorded in S-8 (21.99%). The maximum non-reducing sugar content of the pulp was recorded in D-9 (12.17%) and the minimum was recorded in S-8 (3.67%). The maximum total sugar content of the pulp was recorded in C-4 (46.18%) while the least was recorded in S-8 (25.85%). The level of sugar content in tamarind is due to the ripening of fruits, which is associated with high metabolic changes in the fruits leading to the conversion of complex polysaccharides into simple sugars. The variation in sugar content is attributed to the difference in acidity content of the pulp and found to vary within and between the genotypes. The similar outcome with respect to the above characters were earlier reported by Patil (2004) [11], Prabhushankar *et al*. (2004) [12], El-Siddig *et al.* (2006) [7], Divakara (2009) [6] Adeola and Aworh (2012) [2], Joshi *et al.* (2013) [9] and Sharma *et al*. (2015) [14].

The association of yield with different quality and yield components in 16 genotypes were estimated and presented in Table 2.

Pod yield per tree exhibited significant and positive association with pod weight (0.6417**), pulp weight (0.6324**), pod length (0.5712**), pod width (0.3317*). While, titrable acidity (0.0876), total sugars (0.0641), total soluble solids (0.0446), pH (0.0260) showed non- significant positive association with pod yield per tree. Hence it might be inferred that these traits could be considered as most important yield contributing traits in tamarind. While, significant negative correlation with ascorbic acid (-0.3370*) was observed. This is in accordance with the findings of Divakara *et al.* (2008) [5], Singh and Nandhini (2014) [15], Bhogave *et al.* (2018) [4] and Mayavel *et al.* (2018) [10].

Pod length showed significant and positive association with pulp weight (0.6169**), pod weight (0.5673**), While, non-significant positive correlation for pod length was observed with pod width (0.2579), total soluble solids (0.2168) and pH (0.1353). Pod width expressed significant and positive correlation with pod weight (0.7546**), pulp weight (0.6752**), While, non-significant positive correlation of pod width was observed with titrable acidity (0.1236) and total sugar (0.0994). The pod weight revealed significant and positive correlation with pulp weight (0.9231**), pod width (0.7546**) and pod length (0.5673**). While, non-significant positive correlation of pod weight was observed with pH (0.2664), titrable acidity (0.2412), total sugar (0.2277) and total soluble solids (0.1791). The pulp weight showed significant and positive association with pod weight (0.9231**), pod width (0.6752**), pod length (0.6169**). While, non-significant positive correlation of pulp weight was observed with pH (0.2764), total sugar (0.2686), titrable acidity (0.2650) and total soluble solids (0.2255). These results are confirmative with findings of Divakara (2008) [5], Algabal *et al.* (2012) [1], Singh and Nandini (2014) [15], Bhogave *et al.* (2018) [4] and Mayavel *et al.* (2018) [10]

The total soluble solids expressed significant and positive association with total sugar (0.9291**).While, non-significant positive correlation of total soluble solids was observed with pH (0.2770), ascorbic acid (0.2524), pulp weight (0.2255), pod length (0.2168) and pod weight (0.1791). The titrable acidity showed non-significant positive association with pulp weight (0.2650), pod weight (0.2412) and pod width (0.1236) while, significant negative correlation with total sugar (-0.8953**), total soluble solids (-0.8810**) and pH (-0.8333**). The ascorbic acid revealed non-significant positive correlation with total soluble solids (0.2524), total sugar (0.1172) and pH (0.0401). While pH exhibited significant and positive association with total sugar (0.3325*) while, total soluble solids (0.2770), pulp weight (0.2764), pod weight (0.2664) and pod length (0.1353) showed non- significant positive association with pH. Total sugar expressed significant and positive association with total soluble solids (0.9291**) and pH (0.3325*) while, non- significant positive association with pulp weight (0.2686), pod weight (0.2277), ascorbic acid (0.1172) and pod width (0.0994) whereas, significant negative correlation with titrable acidity (-0.8953**). Similar results were earlier reported by Mayavel *et al.* (2018) [10].

Table 1: Qualitative parameters of the pulp in tamarind genotypes

Genotypes	TSS (^{0}Brix)	Titrable acidity (%)	Ascorbic acid (mg/100 g of pulp)	pH	Sugars (%)		
					Reducing sugar	Non reducing sugar	Total sugar
K-9	17.60	6.22	7.13	2.85	26.15	7.64	34.19
NTI-52	19.15	5.41	6.19	3.08	30.17	5.04	35.47
K-11	20.91	5.25	5.23	3.17	29.99	11.16	41.72
S-7	19.34	5.62	4.28	2.93	30.66	6.30	37.30
S-8	12.97	11.25	9.51	2.34	21.99	3.67	25.85
S-14	14.71	9.24	8.55	2.56	24.13	4.87	29.26
S-3	21.25	3.10	11.41	3.41	29.66	11.54	41.81
N-6	20.67	5.25	6.64	3.19	31.96	8.65	41.07
D-2	19.34	3.52	10.03	3.32	28.26	11.81	40.72
C-4	21.28	2.55	10.94	3.37	34.06	11.51	46.18
D-9	22.76	3.97	9.51	3.22	30.91	12.17	43.72
NTI-89	19.97	5.47	5.71	3.01	30.42	7.57	38.72
D-19	17.31	7.21	8.09	2.69	25.86	5.53	31.69
S-6	12.38	10.35	10.46	2.46	22.72	4.25	27.20
K-10	15.70	7.20	12.85	2.73	24.67	5.81	30.78
K-12	18.37	5.71	6.16	2.91	28.03	6.71	35.10
S. Em ±	0.67	0.33	0.38	0.13	0.83	0.46	1.08
C. D @5%	1.94	0.94	1.09	0.38	2.40	1.34	3.12

Table 2: Simple correlation co-efficient matrix for yield and quality parameters in tamarind

EE	1	2	3	4	5	6	7	8	9	r_p
1	1.0000	0.2579	0.5673 **	0.6169 **	0.2168	-0.2176	-0.2387	0.1353	-0.1423	0.5712**
2		1.0000	0.7546 **	0.6752 **	-0.1172	0.1236	-0.0270	-0.0252	0.0994	0.3317*
3			1.0000	0.9231 **	0.1791	0.2412	-0.2486	0.2664	0.2277	0.6417**
4				1.0000	0.2255	0.2650	-0.1535	0.2764	0.2686	0.6324**
5					1.0000	-0.8810**	0.2524	0.2770	0.9291**	0.0446
6						1.0000	-0.0519	-0.8333**	-0.8953**	0.0876
7							1.0000	0.0401	0.1172	-0.3370*
8								1.0000	0.3325*	0.0260
9									1.0000	0.0641

*and ** indicates significant at 5 and 1 percent level probability respectively.

1. Pod length (cm) 2. Pod width (cm) 3. Pod weight (g) 4. Pulp weight per pod (g) 5. Total soluble solids (^{0}Brix) 6. Acidity (%) 7. Ascorbic acid (mg/100g) 8. pH 9. Total sugars (%)

Conclusion

From the present study, it is concluded that, the analysis of variance revealed the existence of considerable variation among the genotypes with respect to yield and quality parameters studied. The higher titrable acidity content was recorded in genotype S-8 (11.25%), reducing sugar (C-4: 34.06%), non-reducing sugar (D-9: 12.17%) and total sugar (C-4: 46.18%). The results of correlation co-efficient analysis revealed that pod length (cm), pod width (cm), pod weight (g), pulp weight (g), titrable acidity (%), total sugar (%), total soluble solids (^{0}Brix) and pH attributes could be effectively used in tamarind improvement programme for selecting genotypes as they show positive association for higher yield.

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