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Genetic Variability Studies in Selected Clones of Red Tamarind (*Tamarindus indica var Rhodocrpha*) for Yield and Quality Traits

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ABSTRACT

An experiment was carried out with 21 red tamarind clones planted in a spacing of 5×5 meters with randomized block design at IFGTB – Field Research Station, Kurumpapatti, Salem, Tamil Nadu. The red tamarind clones were evaluated to determine variability parameters like genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as per cent of mean for fifteen quantitative and qualitative traits. The high genotypic variation was recorded in length of inflorescence, number of flowers/inflorescence, fruit length, fruit breath, fruit weight, pulp weight, seed weight and fruit yield/tree. All the characters registered high phenotypic coefficient of variation then the genotypic coefficient of variation. High phenotypic coefficient of variation, genotypic coefficient of variation, heritability coupled with high genetic advance as per cent of mean was registered in length of inflorescence, number of flowers/inflorescence, fruit yield/tree, fruit length, fruit breadth, fruit weight, pulp weight and seed weight of red tamarind. It is due to additive gene effect and considering these characters would be more effective for selection of elite clones in tamarind improvement programme.

Key words: *Red Tamarind clones, Genetic variability, Yield, Quality parameters.*

INTRODUCTION

Tamarind (*Tamarindus indica* L.) is an important multipurpose, monotypic genus tree species belonging to the family of Leguminaceae with somatic chromosome number of 2n=24[20] and which is also called Indian date[17]. It is a moderate to large size evergreen tropical tree native to Africa and grows well in wide range of soil and climatic conditions. The species widely distributed in tropics, sub tropics and semi-arid region in the Asian and American continents[5]. India is the largest producer of tamarind in the world with the annual production of 300000 tons of which 11,500 tons of pulp annually exported to Europe, Arab and American countries. It is commercially cultivated in the states of Madhya Pradesh, Bihar, Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal.

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Tamarind is mainly grown for acidic fruit pulp which is a main ingredient of many south Indian culinary preparations such as sambar, curries, chutney, jam, jelly and confectionary industries. The fruit pulp has good source of minerals like copper, potassium, calcium, iron, selenium, zinc and magnesium and also contain thiamin, vitamin-A, folic acid, riboflavin, niacin and vitamin-C. Hard wood is used for making wheels mallets, rich funders and very good fortannery. Leaves contain 12 to 15 per cent of crude protein and used as a fodder during dry period[12]. Tamarind kernel powder is widely used for starching of cotton yarns, jute fabrics and woolen. Seed powder also finds place in preparation jelly, fortified bread, biscuits and in the confectionery industry for manufacturing chocolates. Wide variation is recorded in the species due to its out crossing ability and 19327 genotypes are estimated[14] considering exorpident value of the trees, planning and execution of tree improvement programme for increasing qualitative and quantitative attributes depends on assessment of polygene variation, selection of superior genotypes and breeding program. Large variation in tree growth, canopy size, flowering pattern, fruit productivity, pulp colour and sweetness exists in tamarind. Based on the pulp colour tamarind has been delineated as red tamarind and brown tamarind. The red pulp colour in unripe fruits is due to presence of anthocyanin in cell vacuoles which is a natural water soluble, non toxic pigment. The high potential of red tamarind as a bio colorant in food processing, pharmaceutical, brewery and confectionery industries to replace the use of carcinogenic inorganic colorants provide scope for large scale commercial utilization. Knowledge maintenance of diversity and their relationships from genetic to niche in species level is generally the advanced ideal conservation approach for species of economic importance[8,13,18] . Planning of successful breeding programme depends on quantification of variability among the traits and the association in relation to yield and yield attribute[1,16]. Successful tamarind tree improvement program depends on magnitude of genetic variability and heritability of various quantitative and qualitative traits. The nature and magnitude of the variability in the breeding population is estimated by GCV and PCV. Very limited research work was carried out to assess the variability in red tamarind Germplasm. In the view of above facts, the present investigation was carried out among 21 promising genotypes of red tamarind to study the existing genetic variability for further utilization in tree improvement programme.

MATERIAL AND METHODS

The experiment was conducted to evaluate 21 genotypes of red tamarind at Institute of Forest Genetics and Tree Breeding, Forest Research Station, Kurumbapatty, Salem, Tamil Nadu. A Well planned survey was conducted for selection of red tamarind germplasm from different parts of Tamil Nadu, Puducherry, Karnataka and Andhra Pradesh for a period of 3 years from 2006-2008. The selected red tamarind plus trees were multiplied through cleft grafting and planted in random block design (RBD) with 4 replications. Clones were planted in the spacing of 5×5 meters and 3 ramets/replication were maintained. The field trail was established in 2008 and evaluated during fruiting season of 2014-2015. The lengths of inflorescence, number of flowers/inflorescence, number of fruits/inflorescences were recorded from 25 randomly selected secondary shoots and average was calculated. Actual fruit yield was calculated from individual trees and mean yield were calculated. About 25 fruits/replication were collected from selected red tamarind clone during ripening stage for recording length and breadth of fruits, fruit weight, pulp weight, number of seeds and seed weight. The anthocyanin content was assessed in 90 days old unripe fruits as per the method suggested by Giusti and Wrolstad[9]. The total soluble solids (TSS) and total sugars were quantified by AOAC standard methods. Acidity and ascorbic acid were estimated as per standard methodology by Rangana[21]. The analysis of variance for testing the variance

among treatments was carried out as per the method suggested by Panse and Sukhatme[18]. The genotypic and phenotypic coefficients of variation were calculated according to the formula given by Falconer[6]. Categorization of the range of variation was proposed by Sivasubramaniam and Madavamenon[24]. Heritability (h^2) in the broad sense was calculated according to the formula given by Burton[2]. The range of heritability and genetic advance as per cent of mean (GAM) were classified as suggested by Johnson *et al*[11].

RESULTS

The analysis of variance for yield and quality traits showed highly significant difference among the red tamarind (Table 2). It indicates the presence of variability in the genetic resources selected for the study and this will provide the scope for selection of suitable initial breeding material for tamarind tree improvement. However, the total variability in different characters does not give information on identification of the characters showing the highest degree of variability. Therefore the estimates of GCV and PCV are needed for quantifying the extent of variability in different characters. The extent of variability present in the 21 clones of red tamarind was measured in terms of mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent of mean (GAM) are presented in Table 3.The wide range was recorded for length of inflorescence (13.32 cm and 5.20 cm), number of flowers/inflorescence (27.15 and 10.86), yield/tree (40.26 kg and 14.56 kg), fruit length (12.02 cm and 4.96 cm), fruit breadth (3.15 cm and 1.32 cm), fruit weight (13.94 g and 4.89 g), pulp weight (7.99 g and 2.50 g), number of seeds (8.10 and 3.92), seed weight (7.86 g and 1.93 g) and anthocyanin content (246.94 mg/L and 123.06 mg/L). It indicates the presence of variability among the clones used in the present investigation and it will help in selecting outstanding clone in the existing clonal assemblage. However, number of fruits/inflorescence (1.48 and 0.52), total soluble solids (7.96 and 7.10), total sugar (34.16 % and 27.24 %), acidity (5.64 % and 3.34 %) and ascorbic acid (3.96 mg/gm and 3.10 mg/gm) were recorded in minimum variation and these characters have less scope for selection. The estimates of phenotypic coefficient of variation were higher than the genotypic coefficient of variation for all the floral and fruit characters of red tamarind. The results indicated the influence of environment on the expression of the characters. The PCV ranged from 7.12 to 40.75 and GCV ranged from 2.54 to 39.89 among all quantitative and qualitative traits of red tamarind. Higher estimates of phenotypic and genotypic coefficient of variation were obtained for length of inflorescence (27.12 % and 25.93 %), number of flowers/inflorescence (27.00 % and 25.82 %), yield/tree (38.57 % and 37.66 %), fruit length (24.85 % and 23.57 %), fruit breadth (25.95 % and 24.69 %), fruit weight (27.24 % and 26.06 %), pulp weight (26.69 % and 25.52 %) and seed weight (40.75 % and 39.89 %). The moderate PCV and GCV were recorded in number of fruits/inflorescence (17.89 % and 16.09 %), number of seeds (18.47 % and 16.80 %), anthocyanin content (17.48 % and 15.73 %) and acidity (17.39 % and 5.61 %). Whereas total soluble solids (TSS) (7.12 % and 2.54 %), total sugars (9.12 % and 5.11 %) and ascorbic acid (9.22 % and 5.32 %) recorded low PCV and GCV values. These seven characters have lesser scope for selecting outstanding parents in the tree improvement programme. GCV does not give entire variation present in the population and the variation in the population is the sum total of heritable and non-heritable components. Higher heritability estimates indicate that the phenotype of the traits is strongly influenced by genotype. The heritability value ranged from 13 % (total soluble solids) to 96 % (seed weight). In present investigation, high heritability was recorded in all the quantitative and qualitative traits of red tamarind except total soluble solids (low), total sugars and ascorbic acid (moderate). The genetic advance as per cent of mean ranged from 1.87 % to 80.46 % and the higher value of genetic

advance as per cent a mean recorded all the characters expect total soluble solids, total sugars and ascorbic acid (low). It might be due to high range of variation among the genotypes. The seed weight has highest genetic advance as per cent of mean (80.46 %) followed by yield/tree (75.74 %) whereas the lowest value was recorded in total soluble solids (1.87 %). High heritability estimates coupled with high genetic advance as per cent of mean were observed in all the character except total soluble solids, total sugars and ascorbic acid. It is an indicative of additive gene action and selection based on these characters would be more reliable. Moderate/low heritability with low genetic advance as per cent of mean value observed in total soluble solids, total sugars and ascorbic acid (Table 3). It might attribute to the presence of non-additive gene action which indicates dominance/epistasis and their response to selection would be poor.

DISCUSSION

Tamarind is a hardy, multipurpose, popular spice tree which is grown in wasteland, unattended backyards and avenues. The acidic fruit pulp is regularly used in south Indian household preparations like sambar, rasam, puliogare and also used for fruit pulp, juice concentrate and kernel powder, has tremendous demands in internal and external markets. Wide variation in tamarind seedlings are expected with broad genetic base due to its cross pollinating nature. Variation in the pulp colour of tamarind has been delineated as red tamarind and brown tamarind. The red pulp colour in unripe fruits is due to presence of anthocyanin and has a great scope for utilizing as bio colourant in food processing, pharmaceutical, brewery and confectionery industries. The knowledge on genotypic and geographical variations is fundamental importance for the development of new varieties with good quality and higher yields[7,10]. The relative values of PCV and GCV give an idea about the magnitude of variability present the genetic population. Estimates of GCV lower than PCV for many traits which implies the role of environment in the expression of the traits[3]. In present investigation, higher estimates of phenotypic and genotypic coefficient of variation were obtained for length of inflorescence, number of flowers/inflorescence, yield/tree, fruit length, fruit breadth, fruit weight, pulp weight and seed weight. It indicates that the environment play important role for expression of the characters and these characters were considered for selection of outstanding genotypes of tamarind. Santhi[22] reported high heritability and genetic advance as per cent of mean for pulp weight and moderate heritability and genetic advance for pod length and number of seeds/pod. The present investigation reveals that high heritability was recorded for all the quantitative and qualitative traits of red tamarind except total soluble solids, total sugars and ascorbic acid. Selections of genotypes with high heritable characters are best for any tree improvement programme. Due to existence of huge variation, higher value of genetic advance as per cent of mean was recorded for all the characters expect total soluble solids, total sugars and ascorbic acid. The seed weight and yield/tree has highest genetic advance as per cent of mean and the lowest value was recorded in total soluble solids, total sugars and ascorbic acid. All characters except total soluble solids, total sugars and ascorbic acid with high heritability and high genetic advance as per cent of mean are due additive gene action and selection of these traits would be effective in tree improvement programme. Total soluble solids, total sugars and ascorbic acid shows moderate/low heritability with low genetic advance as per cent of mean. It might attribute to the presence of non-additive gene action which indicates dominance/epistasis and their response to selection would be poor. Present finding are in accordance with the finding of Singh and Nandhini[23], Patil shekar and Hanamashetti[19] and Divakara[4].

Table 1: Selected red tamarind genetic resources in Southern India

S.No.	Tree Code	Tree name	GPS Position		Elevation
1	TVTVR-1	Vengalapuram Red - 1	N 11°45.140'	E 78°09.417'	367
2	TTCER-1	Eraiyur Red - 1	N 12°06.186'	E 78°54.464'	369
3	TVAMR-1	Machempattu Red - 1	N 12°51.479'	E 78°42.390'	360
4	TVGPR-1	Peranampet Red - 1	N 12°55.671'	E 78°42.916'	358
5	TDNNR-1	Natham Red - 1	N 10°18.241'	E 78°03.677'	348
6	TTPJR-1	Jayamangalam Red - 1	N 10°06.164'	E 77°36.182'	352
7	TTPJR-2	Jayamangalam Red - 2	N 10°06.164'	E 77°36.181'	272
8	TTPJR-3	Jayamangalam Red - 3	N 10°06.176'	E 77°36.176'	272
9	TTPPR-4	Podi Red - 4	N 10°01.249'	E 77°20.341'	349
10	TVRRR-1	Rajapalayam Red - 1	N 10°06.164'	E 77°36.182'	352
11	TVGSR-4	Shivaraj Nager Red - 4	N 12°56.048'	E 78°42.243'	364
12	TKUNR-1	Nelluvai Red - 1	N 11°00.885'	E 76°56.655'	419
13	TVAKR-1	Kedampur Red - 1	N 12°50.248'	E 78°42.548'	413
14	TMPKR-1	Kuvalapuram Red - 1	N 09°41.091'	E 77°45.504'	389
15	TCPPR-1	Pollachi Red - 1	N10° 44' 52.85"	E77° 6' 0.73"	354
16	PKKKR-1	Karaikal Red - 1	N 10°57.013'	E 79°46.519'	3
17	PKKKR-2	Karaikal Red - 2	N 10°56.992'	E 79°46.519'	3
18	AHHMR-1	Meduk Red - 1	N18° 3'11.78"	E78° 16'2.42"	467
19	AHHMR-2	Meduk Red - 2	N18°3'13.28"	E78°16' 3.26"	468
20	KKPCR-1	Chittampalli Red - 1	N13°0' 32.89"	E78°29' 28.74"	725
21	KCKKR-1	Kadur Red - 1	N13°33' 11.02"	E76 °0' 52.57"	773

Table 2: Analysis of variance (mean squares) for fifteen qualitative and quantitative traits of selected tamarind trees

S.No.	Characters	Source of variation			SED	CD
		Replications	Treatments	Error		
	Degree of freedom	2	20	40		
1	Length of inflorescence (cm)	1.55	18.89	0.57	0.62	1.25
2	Number of flowers/inflorescence	6.98	79.26	2.40	1.27	2.56
3	Number of fruits/inflorescence	0.03	0.13	0.01	0.08	0.16
4	Yield/tree (kg)	6.11	193.01	3.10	1.44	2.91
5	Fruit length (cm)	1.30	12.92	0.46	0.56	1.13
6	Fruit breadth (cm)	0.09	1.05	0.04	0.15	0.31
7	Fruit weight (g)	1.81	20.53	0.61	0.64	1.29
8	Pulp weight (g)	0.56	5.55	0.17	0.34	0.68
9	Number of seeds	0.66	2.96	0.19	0.36	0.73
10	Seed weight (g)	0.20	5.49	0.08	0.23	0.46
11	Anthocyanin content (mg/litre)	820.73	3029.47	219.90	2.11	24.47
12	Total soluble solids (TSS)	1.18	0.22	0.33	0.47	0.94
13	Total sugar (%)	18.61	12.11	5.11	1.85	3.73
14	Acidity (%)	0.41	1.59	0.12	0.28	0.57
15	Ascorbic acid (mg/gm)	0.27	0.17	0.07	0.21	0.43

Table 3: Estimates of genetic parameters for yield, yield contributing and quality characters in selected Tamarind trees

S.No.	Characters	Range		Mean	PCV (%)	GCV (%)	Heritability (BS) (%)	GAM (%)
		Min.	Max.					
1	Length of inflorescence (cm)	5.20	13.32	25.93	27.12	25.93	91.00	51.07
2	Number of flowers/inflorescence	10.86	27.15	25.82	27.00	25.82	91.00	50.85
3	Number of fruits/inflorescence	0.52	1.48	16.09	17.89	16.09	81.00	29.83
4	Yield/tree (kg)	14.56	40.26	37.66	38.57	37.66	95.00	75.74
5	Fruit length (cm)	4.96	12.02	23.57	24.85	23.57	90.00	46.04
6	Fruit breadth (cm)	1.32	3.15	24.69	25.95	24.69	91.00	48.41
7	Fruit weight (g)	4.89	13.94	26.06	27.24	26.06	92.00	51.38
8	Pulp weight (g)	2.50	7.99	25.52	26.69	25.52	91.00	50.26
9	Number of seeds	3.92	8.10	16.80	18.47	16.80	83.00	31.48
10	Seed weight (g)	1.93	7.86	39.89	40.75	39.89	96.00	80.46
11	Anthocyanin content (mg/litre)	123.06	246.94	15.73	17.48	15.73	81.00	29.15
12	Total soluble solids (TSS)	7.10	7.96	2.54	7.12	2.54	13.00	1.87
13	Total sugar (%)	27.24	34.16	5.11	9.12	5.11	31.00	5.89
14	Acidity (%)	3.34	5.64	15.61	17.39	15.61	81.00	28.87
15	Ascorbic acid (mg/gm)	3.10	3.96	5.32	9.22	5.32	33.00	6.33

CONCLUSION

Selection and conservation of red tamarind genetic resources with broad genetic base is essential for developing new clones with higher yield and quality. Exploiting available variation is mandatory for domestication and clonal deployment of red tamarind with desirable traits. The higher value of PCV, GCV, heritability coupled with high genetic advance as per cent of mean was registered in length of inflorescence, number of flowers/inflorescence, fruit yield/tree, fruit length, fruit breadth, fruit weight, pulp weight and seed weight of red tamarind. Hence these characters are considered for development of new clones in red tamarind.

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