The Pharma Innovation Journal 2023; 12(12): 1417-1421

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 1417-1421

www.thepharmajournal.com
Received: 04-09-2023
Accepted: 09-10-2023

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Evaluation of quantitative and morphological characters of tamarind (*Tamarindus indica* L.) genotypes

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Abstract
An experiment was carried out with 25 tamarind genotypes at Research cum Demonstration Farm of the Department of Horticulture, College of Agriculture, Dhule, Maharashtra, during 2021-22 to assess the quantitative and morphological characters of genotypes. Significant variations were observed among the genotypes with respect to quantitative characters *viz*., tree height (15.2 m), tree volume (2153.09 m^3), tree circumference (236.6 cm), tree spread (E-W) (16.6 m), tree spread (N-S) (18.7 m), pod length (21.31 cm), pod girth (7.97 cm), pod width (3.02 cm), pod thickness (1.95 cm), pod weight (34.58 g), pod yield per plant (183.5 kg), pulp weight (18.86 g), shell weight (9.47 g), fibre weight (1.24 g), seed weight per pod (6.14 g), number of seeds per pod (11.1), pulp percentage (54.64%), shell percentage (36.50%), fibre percentage (7.11%) and seed percentage (39.07%). The morphological variation recorded were pod colour (whitish light brown, light brown, brown and dark brown) and pod shape (straight, slightly curved, curved and deeply curved). Among 25 genotypes studied ACDT-9 was found superior with respect to pod length, pod width, pod girth, pod thickness, pod weight, pulp weight, seed weight, number of seeds per pod and pod yield per plant. Hence, genotype ACDT-9 is most promising and has great potential, which can be used for further evaluation.

Keywords: Tamarind, tree characters, pod characters, morphological characters, variations

Introduction
Tamarind (*Tamarindus indica* L.) a tropical fruit tree and is known as "Date of India". It is an evergreen monotypic genus which belongs to the dicotyledonous family Fabaceae, sub-family Caesalpiniaceae. It is a diploid species with chromosome number 2n=24 (Purseglove, 1987) [12]. Tamarind is multipurpose fruit tree of which almost every part finds atleast some use (Kumar and Bhattacharya, 2008) [4], either nutritional or medicinal. The sticky acidic pulp of tamarind fruit has been used as a food ingredient and medicine for many years. Fruits of tamarind are consumed fresh or processed as well as it can be utilized for seasoning or as a spice. In addition, it has potential to widen food basket due to its nutritive value and health benefits which will help to alleviate malnutrition and under nutrition.

Tamarind has great commercial significance due to its multipurpose uses and ability to grow in marginal soils and withstand adverse agro climatic conditions (Karale, 2002) [3]. It is an excellent tree for social and agro forestry in the waste land development and dry land horticulture. Despite of its versatile nature, tamarind could not gain commercial status and it remained as underutilized fruit crop. Being highly cross-pollinated crop, seedling originated crop exhibit wide variability with respect to tree and pod characters. It is very essential to study the existence of variability among several genotypes to select the genotypes with superior characteristics for better yield and quality fruits.

There is 33 years old orchard of tamarind on the research cum Demonstration Farm of Department of Horticulture, College of Agriculture, Dhule which are seedling origin. These tamarind plants show wide variability with respect to tree, pod characters, morphological characters, etc. This variability offers great opportunity for genetic improvement of this crop.

Materials and Methods
An experiment was carried out at Research cum Demonstration farm of Department of Horticulture, College of Agriculture, Dhule, Maharashtra, during 2021-22. The material for present study comprised of 25 randomly selected tamarind genotypes, which are seedling originated plants at College of Agriculture, Dhule.

The observations on twenty two quantitative and morphological parameters including tree growth characters *viz.*, tree height (m), tree circumference (cm), tree volume (m^3), tree spread (E-W) (m), tree spread (N-S) (m), fruit and yield characters *viz.*, Pod weight (g), pod length (cm), pod width (cm), pod thickness (cm), pod girth (cm), Pod yield per plant (kg), pod shape, pod colour, fibre weight (g), seed weight per pod (g), shell weight (g), pulp weight (g), pulp percentage (%), shell percentage (%), fibre percentage (%), seed percentage (%), number of seeds per pod were recorded for each genotype under study.

Table 1: Variations in tree growth characters of different genotypes in tamarind

Sr. No.	Name of genotype	Tree height (m)	Tree spread (m)		Tree volume (m^3)	Tree circumference (cm)
			E- W	N- S		
1	ACDT-1	8.3	15.8	14.6	1004.07	180.4
2	ACDT-2	8.8	11.3	12.5	652.49	108.5
3	ACDT-3	9.7	13.4	11.9	812.74	162.8
4	ACDT-4	8.4	11.2	10.2	503.55	138.7
5	ACDT-9	12.2	9.6	10.4	638.79	85.5
6	ACDT-14	14.9	7.5	8.3	486.90	65.9
7	ACDT-20	6.4	8.2	8.3	228.08	126.2
8	ACDT-21	9.4	7.2	8.4	299.44	193.8
9	ACDT-27	12.2	10.4	11.1	738.20	182.5
10	ACDT-32	13.6	13.8	14.3	1405.69	163.1
11	ACDT-45	7.2	12	11.3	511.66	83.3
12	ACDT-54	14.8	10.6	11.2	920.69	147.8
13	ACDT-55	15.2	9.8	11.4	894.24	162.8
14	ACDT-58	9.3	8.4	9.3	381.39	157.1
15	ACDT-62	12.6	11.6	13.2	1014.41	127.4
16	ACDT-63	11.8	12.5	13.3	1028.16	205.3
17	ACDT-70	13.5	7.6	8.9	481.11	140.2
18	ACDT-85	15.2	14.2	15.1	1708.12	164.3
19	ACDT-92	9.6	8.3	9.2	384.85	105.4
20	ACDT-105	11.5	7.1	6.8	290.85	83.1
21	ACDT-106	13.2	16.6	18.7	2153.09	236.6
22	ACDT-112	8.2	9.2	12.6	510.11	154.6
23	ACDT-113	8.5	7.2	6.9	221.21	184.2
24	ACDT-119	8.4	7.6	7.9	264.17	74.98
25	ACDT-132	8.1	13.3	12.5	705.77	124.6
	MEAN	10.84	10.57	11.13	729.59	142.36

Table 2: Variations in fruit characters of different genotypes in tamarind

Name of Genotype	Pod length (cm)	Pod width (cm)	Pod thickness (cm)	Pod girth (cm)	Pod weight (g)	Pod yield /tree (kg)	Pod shape	Pod colour
ACDT-1	10.02	2.17	1.56	6.06	9.88	153.85	Straight	B
ACDT-2	14.2	1.62	1.21	4.88	8.42	111.12	Curved	WLB
ACDT-3	19.21	2.12	1.38	5.85	13.15	112.37	Deeply curved	LB
ACDT-4	14.35	2.70	1.74	7.08	15.66	48.33	Slightly curved	DB
ACDT-9	21.31	3.02	1.95	7.97	34.58	183.5	Curved	B
ACDT-14	13.7	2.29	1.56	6.84	18.96	37.2	Slightly curved	DB
ACDT-20	13.44	2.47	1.49	6.83	14.67	18.6	Straight	B
ACDT-21	12.62	2.09	1.42	6.99	12.2	58.22	Straight	LB
ACDT-27	15.33	2.42	1.26	6.28	13.48	87.98	Slightly curved	WLB
ACDT-32	18.94	1.96	1.25	4.72	9.98	103.64	Curved	LB
ACDT-45	19.35	2.94	1.76	7.79	29.36	147.12	Slightly curved	B
ACDT-54	11.57	1.98	1.37	5.96	9.16	77.89	Straight	WLB
ACDT-55	14.49	2.64	1.34	6.42	14.59	181.25	Slightly curved	B
ACDT-58	10.23	2.21	1.45	6.27	9.66	45.53	Straight	LB
ACDT-62	5.92	1.53	1.31	5.23	4.53	12.84	Straight	DB
ACDT-63	11.28	1.95	1.43	5.57	8.84	46.48	Slightly curved	LB
ACDT-70	9.87	2.29	1.68	5.46	7.94	36.32	Straight	B
ACDT-85	13.9	2.33	1.31	7.19	12.07	32.84	Straight	B
ACDT-92	13.53	1.74	1.29	5.47	9.24	34.13	Deeply curved	LB
ACDT-105	13.15	2.29	1.50	6.71	12.23	38.21	Slightly curved	LB
ACDT-106	10.15	2.27	1.60	6.55	8.25	115.66	Slightly curved	LB
ACDT-112	10.44	2.21	1.61	6.76	10.34	69.14	Slightly curved	B
ACDT-113	10.29	2.20	1.59	6.01	10.57	35.15	Straight	WLB
ACDT-119	13.82	2.96	1.62	7.72	15.59	72.18	Slightly curved	LB
ACDT-132	12.61	1.69	1.27	4.55	6.94	61.63	Deeply curved	WLB
MEAN	13.34	2.24	1.47	6.28	12.87	76.84		

Where, B - Brown, LB - Light brown, WLB - Whitish light brown, DB - Dark brown

Table 3: Variations in shell, fibre, pulp and seed characters of different genotypes in tamarind

Sr. No.	Name of Genotype	Shell weight (g)	Shell %	Fibre weight (g)	Fibre %	Pulp weight (g)	Pulp %	Seed weight (g)	Seed %	No. of seeds/pod
1	ACDT-1	2.22	22.49	0.31	3.14	4.89	49.54	2.45	24.82	5.2
2	ACDT-2	3.07	36.50	0.28	3.32	3.28	39	1.78	21.16	7.4
3	ACDT-3	4.03	30.64	0.36	2.73	5.93	45.09	2.83	21.52	11
4	ACDT-4	3.95	25.23	0.46	2.93	7.99	51.05	3.25	20.76	6.7
5	ACDT-9	8.48	24.51	1.11	3.20	18.86	54.52	6.14	17.75	11.1
6	ACDT-14	5.64	29.42	0.96	5.06	8.84	46.11	3.52	18.36	7.5
7	ACDT-20	4.98	33.97	0.49	3.34	6.02	41.06	3.17	21.62	7.8
8	ACDT-21	4.27	35	0.75	6.14	4.35	35.65	2.83	23.19	7.8
9	ACDT-27	3.23	23.97	0.46	3.41	6.94	51.52	2.84	21.08	7.2
10	ACDT-32	3.18	31.86	0.71	7.11	4.25	42.58	1.84	18.43	10.2
11	ACDT-45	9.47	31.75	1.24	4.22	13.72	46.00	4.93	16.53	7.9
12	ACDT-54	2.85	31.14	0.28	3.06	4.31	47.10	1.71	18.68	4.8
13	ACDT-55	4.58	30.75	0.82	5.62	5.32	35.72	3.87	25.99	6.5
14	ACDT-58	2.91	30.15	0.3	3.10	3.64	37.72	2.8	29.01	4.3
15	ACDT-62	1.54	34.07	0.14	3.09	1.75	38.71	1.09	21.11	2.2
16	ACDT-63	2.11	23.89	0.21	2.37	3.06	34.65	3.45	39.07	6.1
17	ACDT-70	2.29	28.87	0.2	2.52	3.59	45.27	1.85	23.32	3.0
18	ACDT-85	2.72	22.55	0.68	5.63	6.59	54.64	2.07	17.16	5.6
19	ACDT-92	2.99	32.39	0.42	4.55	3.52	38.13	2.3	24.91	7.1
20	ACDT-105	3.27	26.75	0.56	4.58	5.1	41.73	3.29	26.92	5.7
21	ACDT-106	2.33	28.27	0.27	3.27	3.32	40.29	2.32	28.15	4.6
22	ACDT-112	3.03	29.33	0.35	3.38	4.95	47.91	2	19.36	4.5
23	ACDT-113	3.17	29.99	0.37	3.50	3.74	35.38	3.28	31.03	4.4
24	ACDT-119	5.67	35.04	0.79	5.06	6.76	41.78	2.37	14.64	4.5
25	ACDT-132	1.77	25.50	0.22	3.17	2.39	34.43	2.56	36.88	7.2
	MEAN	3.75	29.36	0.57	4.21	5.72	43.02	2.82	23.25	6.41

Results and Discussion

In the present investigation, all the quantitative characters showed significant variation between the selected tamarind genotypes indicating the presence of adequate variability. The result of quantitative characters of tamarind genotypes are presented in (Table 1, 2 and 3). Variability studies revealed that, the maximum tree height (15.2 m) was recorded in ACDT-55 and ACDT-85 and minimum (6.4 m) was recorded in ACDT-20. Similar findings were reported by Rajamanickam (2019) [8] and Pooja *et al.* (2022) [9] in tamarind. The maximum tree volume (2153.09 m^3) was recorded in ACDT-106 and lowest (221.21 m^3) was recorded in ACDT-113. The highest tree circumference (236.6 cm) was recorded in ACDT-106 and lowest (65.9 cm) was recorded in ACDT-14. The maximum tree spread in East-West direction (16.6 m) was recorded in ACDT-106 and the lowest (7.1 m) was recorded in ACDT-105. The maximum tree spread in North-South direction (18.7 m) was recorded in ACDT-106 and the lowest (6.8 m) was recorded in ACDT-105. These results are in harmony with those reported by Prabhushankar (2001) [7].

There was a significant difference among the different tamarind genotypes with respect to pod characters. Among the 25 genotypes the highest pod length (21.31 cm) was recorded in ACDT-9 and the lowest (5.92 cm) was recorded in ACDT-62. The maximum pod girth (7.97 cm) was recorded in ACDT-9 and minimum (4.55 cm) was recorded in ACDT-132. The maximum pod width (3.02cm) was recorded in ACDT-9 and the lowest (1.53 cm) was expressed in ACDT-62. The maximum pod thickness (1.95 cm) was recorded in ACDT-9 and minimum (1.21 cm) was recorded in ACDT-2. The maximum pod weight (34.58 g) was recorded in ACDT-9 and minimum (4.53 g) was recorded in ACDT-62. The maximum pod yield per plant (183.5 kg) was recorded in ACDT-9 and minimum (12.84 kg) was recorded in ACDT-62. The above results on similar lines were also reported by Pooja *et al.* (2018) [6], Rajamanickam (2019) [8] and Mishra *et al.* (2022) [11].

The maximum pulp weight (18.86 g) was recorded in ACDT-9 and minimum (1.75 g) was recorded in ACDT-62. The maximum shell weight (9.47 g) was recorded in ACDT-45 and the lowest (1.54 g) was recorded in ACDT-62. The maximum fibre weight (1.24 g) was expressed in ACDT-45 and the lowest (0.14 g) was recorded in ACDT-62. The maximum seed weight per pod (6.14 g) was recorded in ACDT-9 and the lowest (1.09 g) was recorded in ACDT-62. The maximum number of seeds per pod (11.1) was recorded in genotype ACDT-9 and lowest number of seeds per pod (2.2) was recorded in ACDT-62. Variation in tamarind genotypes with regard to above characters were earlier reported by Rajamanickam (2019) [8] and Mishra *et al.* (2022) [11].

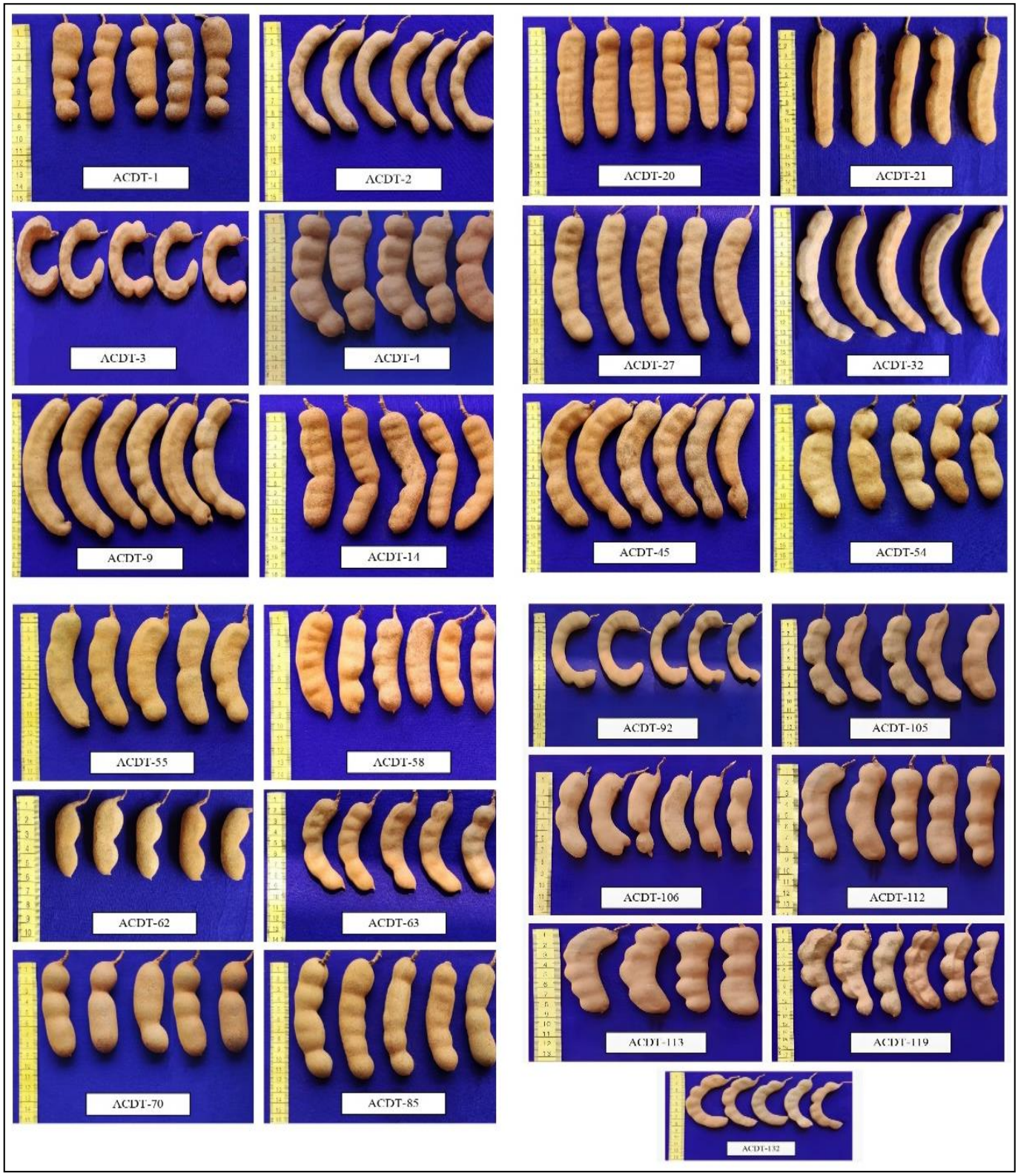
The maximum pulp percentage (54.64%) was recorded in ACDT-85 and minimum (34.43%) was recorded in ACDT-132. The maximum shell percentage (36.50%) was recorded in ACDT-2 and minimum (22.49%) was recorded in ACDT-1. The maximum fibre percentage (7.11%) was recorded in ACDT-32 and minimum (2.37%) was recorded in ACDT-63. The maximum seed percentage (39.07%) was recorded in ACDT-63 and minimum (14.64%) was recorded in ACDT-119.

The different pod colours recorded were whitish light brown, light brown, brown and dark brown (whitish light brown in 5 genotypes, light brown in 9 genotypes, brown in 8 genotypes and dark brown in 3 genotypes) and the different pod shapes recorded were straight, slightly curved, curved and deeply curved (straight in 9 genotypes, slightly curved in 10 genotypes, curved in 3 genotypes and deeply curved in 3

genotypes). The results on similar lines were also reported by Pooja *et al*. (2022) [9] in tamarind.

The variations in the weight of pod, pulp, seed, shell, and fibre was due to their genotypic differences. The difference in the pod length, pod width and pod thickness may be attributed to genetic difference among the genotypes (Shivanandam and Thimmaraju 1988; Hanamashetti, 1996) [10, 2].

Thus, it can be concluded that the natural wealth of tamarind has greater diversity in quantitative and morphological characters, which offer immense scope for further improvement in tamarind through selection of superior genotypes, especially for higher pod yield and pulp content. From the result of present investigation the huge variation was noticed among the 25 genotypes for all the characters. Among 25 genotypes ACDT-9 recorded significantly high pod yield per plant than other genotypes. Other attributes like pod length, pod width, pod girth, pod thickness, seed weight, number of seeds per pod, pulp weight and pod weight were also considerably high in this genotype. Hence this genotypes may be further utilized for selecting superior genotype having major plus characters.



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