Hybrid Coconut-Tall X Dwarf. A comparative study with parental types

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Introduction

Ordinary Indian Tall coconut (Cocos nucifera Linn-var, typica) and Dwarf (Cocos nucifera Linn-var. nana) are the two distinct group of coconuts most familiar to the coconut cultivators. Handover (1919), Anon (1921), Jack and sands (1922) believe ' Dwarf to be a mutant from Tall variety. what ever may be the case, they now behave like two distinct forms differing in characters such as height, leaf length number of leaves in the crown, age at first flowering, longevity, nut characters, yield, copra content, oil content, etc. Several other varieties described by various workers, Copeland (1931), Cook (1901), Mandiola (1926), Wester (1918) and Patel (1938) are only ecotypes of these forms

The popular Tall variety recommended for economic plantations possess certain defects such as long pre-bearing period from 8 to 12 years and long interval for attaining steady bearing stage from 20-25 years after planting.

The Dwarf variety is noted for its early bearing within 3 to 3½ years, early attainment of steady bearing and prolific yield in early stages. But its disadvantagesare short life, alternate bearing, production of small size nuts with poor quality copra and oil, make it unpopular for economic planting.

Jack and Sands (1929 have studied Tall and Dwarf of same age groups and compared their yield, copra and oil content in different ages. Cook and Jagoe (1933) have also studied about the recovery of copra and proved the superiority of Tall variety. Rao and Koyamu (1955) have made a detailed study of Dwarf varieties by comparing the economic characters with that of Tall. They concluded that, Dwarf is unfit for economic planting.

Breeding in agricultural crops is adjudged as a promising line of crop improvement and has resulted in the production of new types. Early in 1925, jack pointed out that natural crossing takes place between Tall and Dwarf races of coconut and semi-tails and intermediaries occur as first generation hybrids of such crossings. Controlled cross pollination between Tall female and Dwarf male was first done in India in 1932, The ' hybrids, Tali x Dwarf ' combine the early bearing characters of Dwarf and the economic nut characters of Tall.

Review of literature

Among the Dwarf, the Green maintains almost cent per cent purity (Rao and Koyamu 1955). This is due to the over-lapping of mate and female phases. Besides this, the upward facing of the stigmatic end of the female flowers, as recorded by the authors enhances the chances of self-pollination within the same panicle.

High yielding and regular bearing Tall mother palms possessing desirable economic charactors were selected as female parents at the Agricultural (Coconut) Research Station, Kasargode, and the first artificial crossing was initiated in 1932. Patel (1937) made a detailed study of these hybrids and recorded that maximum hybrid vigour was met with in this cross. Later studies carried out by C John and G, V. Narayana (1943) and Rao and Koyamu (1952) confirmed the observations,

Rao and Koyamu compared these hybrids with true progenies of parents and pointed out hybrid vigour in seedling stage.

Table I

Hyrid vigour in seedlings stage Rao and Koyamu)

Sl. No.	Particulars	Tall A	T xD. B	Dwarf C	Difference whether significant or not	Critical difference	Conelusion
1.	Mean No. of days taken for germination	98.1	70.2	55.3	Yes	4.67	ABC
2.	Girth at collar in inches	3.6	4.2	3.8	Yes	0.23	BCA
3.	Height in inches.	32.9	40.8	38.4	Yes	2.32	BCA
4.	No. of functioning leaves.	3.8	5.0	5.00	Yes	0.33	BCA

C. M. John and G. V. Narayana (1943) studied the performance of the Tall, TxD and Dwarf when this first plantation attained the age of 5 years and 3 months and established the presence of hyrid vigour in respect of leaf characters and early flowering

Table II

Sl. No,	Characters	Selfed progeny of female parentTall.	Selfed progeny of male parent Dwarf.	Hybrid Tx D
1	Height of trunk above the ground level	No trunk formed.	0′ 9"	1′ 11"
2	Girth of trunk at the base	,,	2′ 1"	2′ 11"

3	No. of leaves in the crown		22	27
4	Mean length of leaf.	12′ 8"	10′ 10*	13′ 0"
5	No. of leaves produced in a year (1941)	9	14	14
6	Age at first flowering	Not flowered.	49 months.	50 months.
7	No. of female flowers produced in ayear		375	433
8	Setting percentage		5.6	11.7
9	Yield of nuts per year		20	51
10	Copra content per nut		20.6 gm.	165.0 gm.
11	Quality of copra		Poor	Good
12	Percentage of oil		70	70

The hybrid was popularised, based on the vigour found in nursery stage and in young palms. But the annual yield, habit of bearing longivity and other characters were only anticipated factors til! recently. In this paper an attempt is made to study in detail the habit of bearing, annual yield rate of growth leaf characters of the hybrid palms and their, superiority over parental ypes.

Meterials and methods.

The first generation hybrids obtained by crossing certain high yielding Tall trees (female parent) with Dwarf Green (male parent) were painted at Agricultural Research Station, Nileshware II during 1935 36 in an area of 2 acres. The naturally pollinated progenies of the same parents and few other mother trees of same performance and natural progenies of Green Dwarf were also planted in the same area during the same period for comparative study.

The plantation is rainfed and receives same mammal and cultural treatment. Now they are 24-25 years old and ready for a more precise and confirmative study So the data accumulated for the past 25 years havebeen taken into consideration to compare certain characters sueh as annual yield, habit of bearing, rate of growth, longivity etc. which will ultimately prove whether a plantation is economical or not But, unfortunately, the soil at Nileshwar II is very poor and unfavourable for coconut and hence the yield data presented cannot be taken as standard for the variety.

For purpose of comprative study, 40 trees of the same age in TallandTxD varieties were selected at random from the total population- In case of Dwarf the population is few and all the available 3 uumbers have been utilised.

RESULTS

1) Age at first **flowering:** —

The data for each variety are presented in table III

TABLE III

Sl. No	Variety.	Serial number of trees. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I.	TxD	4	3	4	4	6	5	7	4	4	5	5	4	4	5	5	3	5	4	5	4	5	6
2.	Tall.	11	3	8	8	17	10	7	8	8	67		717	10	7		9	7	7	8	8	9	8
3.	Dwarf.	3	4	4																			

Si. No.	23	24	25	26	27	28	29	30	3!	32	33	34	35	36	37	38	39	40	Mean
TxD	5	5	6	6	4	4	4	4	5	5	8	5	6	6	4	5	5	5	4.80
Tall.	8	7	7	7	5	5	8	5	6	8	6	8	9	7	8	9	6	7	8.25
Dwarf.																			3.66

It can be seen from the table that considerable reduction in prebearing period is observed in the hybrid.

2) Steady bearing period : —

Early attainment of steady bearing period is another desirable character in coconut. Table IV presents the age at which the tree has attained steady bearing.

SI. No	Variety.	Serial number of trees 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	TxD	6	5	6	6	8	7	8	6	6	7	6	5	1 2	1 2	1 7	5	7	7	7	6
2.	Tall.	17	7	24	18	18	13	9	10	19		9	9	20	12	8	18	18	18	9	18
3.	Dwarf.	5	5	5																	

	21	22	23	24	25	26	,27	28	29	30	31	32	33	34	35	36	37	38	39	40	Mean
I.	7	8	7	7	9	8	5	6	6	5	7	7	24	13	8	13	7	7	7	7	7.92
2.	19	19	12	20	10	8	17	16	23	8	11	9	8	8	19	22	23	19	8	17	14.4
3.																					5.0

T x D attains steady bearing period much earlier than Tall-of all the three, Dwarf attains steady bearing either with the first flowering or in the immediate year.

3) Anuual **yield :—**

The net return from the crop depends upon the annual yield of the tree. Table V presents the age-war annual yield of **all** the three **varieties** for all these years.

TABLE V

Variety.	Age	3	4	5	6	7	8	9	10	U	12	13
T x D	Total of 40 trees.			32	277	651	977	1189	1152	1079	1520	1511
	Mean	—	—	0,8	6.95	16.28	24.42	29.72	28.80	27.48	38.0	37.77
T X D Tall	Total of 40 trees.	—	—	—	*t*	12	55	150	120	102	152	270
	Mean					0.3	1.37	3.75	3.00	2.05	3.75	6.75
Dwarf,	Total of 3 treee			47	27	50	19	23	22	59	23	21
	Mean.			15.66	15.66	15.66	6.33	7.66	7.33	19.66	7.66	7.00

Age	14	15	16	17	18	19	20	21	22	23	24	Total	Mean
Total	1219	1121	1496	1011	2431	1295	1765	1627	1373	1387	1438	24546	1227
Mean	30.47	28.02	37.4	25.27	60.77	32.37	44.02	40.52	34.37	34.66	35.9	613.65	30.
Total	174	I 12	78	119	199	342	385	384	300	302	458	3714	
Mean	4.35	2.80	1.95	2.97	4.97	4.97	8.05	9.06	7.50	7.50	11.45	92.85	5.15
Total	2	U	40	33	58	52	30	23	30	32	55	677	
Mean	0.66	3 66	13.33	11.00	19.33	17.33	:1.00	7.66	1000	10.66	18.33	225.66	

TxD has given the highest total yield and mean yield per year per tree. Dwarf is second and tall is the last With regard to the yield in early ages (3-7 years) Dwar f gives the maximum mean yield and in later period (after 7th year) the maximum yield is given throughout by the TxD variety. Thus T × D garden owner is much benifitted by early receipts and by high yield from the garden.

In graph No. I, curve A, B and C shows mean yield of TxD, Tall and Dwarf in several ages. Curve C takes a rise in the early ages and gradually runs down with the age. Curve B slowly rises. Tn TXD and ta!S yield is still increasing.

In a plantation there will be high, medium and poor yielding trees, Table VI presents the percentage of trees in different yield groups in all the three varieties.

TABLE VI

Variety	Total trees under observation	Yield groups					
		Poor. (40 nuts & below)		Medium (41-80)		(High (81 & above)	
		No of trees	Percentage	No, of trees	per-centage	No of trees	Percent-age
. TXD.	40	20	50%	20	50%	—	
Tall	40	40	100%		—		
Dwarf.	3	3	100%	—	_	—	

A good proportion of trees under high and medium yield group is essential for economic plantation. Difference shown by trees raised from seedlings selected on the basis of same nursery index and grown under identical conditions is due to the genetical characters of the variety.

Table VII represents the annual yield of the maximum yielded trees in all the three varieties in the lot under study.

TABLE VII

Variety.	Tree No.	Age of the tree 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
TxD.	VIII/ 50					90	50	81	48	12	140	37	47	99	47	49	60	61	155	93	104
Tall.	III/508	-	-	-	-	25	23	18	20		23	24	19	23	16	7	12	31	35	22	18
Dwarf.	VIII/117	-	12	27	27	9	14	8	18		10	14		3	16	13	13	12	11	7	14

Age of tree	23	24	Total	Mean / Total \ Bearing period /
TxD (VIII/ 50)	61	54	1298	72.1
Tall (HI/508)	20	31	375	22.0
Dwarf (VIII/1 17)	10	23	261	13.05

In graph No. II, curve A, B and C represents annual yield of TxD, Tall and Dwarf respectively. The mode and depresion of the curve A are similar to B which indicate that habit of bearing of TxD is similar to that of Tall. In dwarf, depresion and rise in curve are dominant, indicating the alternate bearing habit. In TxD the annual yield is also much higher.

4. Leaf Character:—

Leaf character of the tree is also equally important factor. Data for total number of leaves produced so far, number of functioning leaf on the crown and rate of production of leaves are presented in table VIII.

TABLE. VIII

Characters		Sorial No. of trees															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Total leaves produced so far.	Variety T×D	316	300	305	293	357	258	352	321	298	330	320	311	252	244	261	211
	Tall	279	299	254	256	218	249	285	243	227	257	250	260	279	283	245	251
	Dwarf	320	329	315	—	—	—	—	—	—	—	—	—	—	—	—	—
No. of functioning leave on crown	T×D	28	27	23	26	30	22	21	28	30	21	20	26	20	21	22	22
	Tall	18	19	23	23	21	22	22	21	20	21	23	22	21	21	23	12
	Dwarf	24	24	24	—	—	—	—	—	—	—	—	—	—	—	—	—
Rate of production of leaves	T×D	13.5	12.6	14.5	13	14	25	24	14 5	14	19	14	13 5	11	11 5	1 .5	13
	Tall	10.0	10.0	12.5	15 5	12	12	5.5	10 0	10.50	11	9.5	12.5	16.5	10 5	12	
	Dwarf.	15	15 5	13.0	--	—	—	—	—	--	—	--	--	—	—	—	

1.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
T×D	359	350	3 9	327	236	320	322	340	258	269	328	330	272	328	329	249	255
Tall	257	222	25	232	239	223	249	263	232	226	303	265	201	225	267	255	235
Dwarf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

2.	TxD	34	26	22	30	25	25	19	26	21	21	26	19	21	21	26	30	16
	Tall.	19	18	22	18	19	19	21	20	20	18	20	19	19	23	18	24	19
	Dwarf																	
	Tall × D.	14	14	14	11.5	13.5	13.5	9.9	13	12.5	11	12.5	13.5	i 3	12.5	14.5	13.4	
	Tall.	10.5	9.5	11.5	9	11	11	10.5	12	5	5	6.5	9.5	4.5	11	11	10	
	Dwarf.	—	—	—	—	—	—	—		—	—	—		—				

		34	35	36	37	38	39	40	Total	Mean
1.	TxD	298	340	295	225	217	237	258	12195	304.87
	Tall	205	237	226	280	248	232	242	9815	245.37
	Dwarf	—	—	—	—	—	—	—	964	321.33
2.	TxD	21	22	21	23	22	19	27	946	27.15
	Tall	21	20	17	20	16	20	21	801	20.02
	Dwarf	—	—	—	—	—			72	24.00
3.	TXD	12	13	14	12	14	5.5	12	516 50	12.91
	Tall	9.5	105	10	11.5	12.5	9.0	9.5	400.00	10.00
	Dwarf.	—	—	—	—	—	—	—	43.5	14.5

Total number of leaves produced so far and the functioning leaves on the crown are more in TxD than the parental types. But the leaf production is more rapid in case of Dwarf. Tall is poor in all respects. Greater number of functioning leaves on the crown in T x D can be correlated to the extra metabolism the tree performs for increased production.

5. Stem **Characters**

Stem characters are also equally important as it gives certain indications about the longivity of the palm. A plantation is eeonomical only if the tree lives more than 70 years on an average.

In table [X girth, total height and rate of linear growth of the stem are presented.

TABLE IX

Characters	Variety	Serial number of trees												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Girth (1961)	T×D	65	60	66	73	67	63	65	71	65	63	67	67	65
	Tall	65	63	65	66	62	74	71	68	70	73	79	59	70
	Dwarf	51	54	52										
Total height (1961)	T×D	610	490	470	520	585	490	810	505	485	650	510	550	470
	Tall	670	540	350	350	475	635	654	465	455	515	580	545	520
	Dwarf	265	320	285										
Rate of girth (Mean of 3 years)	T×D	6.66	12.33	6.66	11.66	10	12.33	10	11.66	13.33	6.66	10.66	11.6	16.6
	Tall	10	10	12.66	12.66	16.66	18	20	11.66	11.66	8.33	15	1.66	11.66
	Dwarf	5	10	5										

		14	15	16	17	18	19	20	21	22	23	24	25	26	27
1.	T×D	66	72	66	67	63	65	64	68	65	64	61	60	65	72
	Tall	69	71	60	74	65	67	70	66	66	63	64	70	63	66
	Dwarf														
2.	T×D	435	480	505	575	430	420	575	720	575	610	685	580	470	600
	Tall	535	580	520	565	520	505	475	585	570	505	540	620	425	470
	Dwarf														
3.	T×D	15	15	3.33	9.66	6.33	6	10	7.66	8.33	9.33	8.33	12	11.66	8.33
	Tall	10	8.33	15	13.33	10	13.33	11.66	11.66	13	16.66	10	10	14	8
	Dwarf														

		28	29	30	31	32	33	34	35	36	37	38	39	40	Total	Mean
1.	T×D	65	61	61	57	60	63	66	60	69	69	66	60	71	2600	65 cms
	Tall	67	69	71	63	72	50	65	71	63	63	63	70	74	2892	63.3 cms.
	Dwarf														157	52.3 cms.

2.	TxD	500	500	510	500	580	350	405	490	520	480	595	435	565	12121	528 cms.
	Tall	400	505	610	510	645	450	465	435	570	495	405	590	455	20550	513.75 cms.
	Dwarf														270	290 cms.
3.	TXD	It	8.33	5	6.66	tO	12.66	11.66	15	10	]0	6.66	7.66	6,33	288.99	9.72 cms.
	Tall	8.33	5	3.33	5	18.,33	18.33	15	11.66	9.33	8.33	10	5	6 66	446.22	11.15 cms.
	Dwarf														20.0	6.66 cms.

The rate of growth recorded is the average for the last 3 years (i.e. 21-24th year). Themean of ' total height * is more in case ofTxD, girth and rate ofgrowth is more in Tall. Dwarf is far below for all the three characters. If could be seen from the table that the mean values of these characters for Tall and T x D have a very narrow margin indicating the inheritance of stem characters in T x D is from maternal side ie Tall. Tall nature is correlated to long life and hence longivity similar to that of female parent can be expected in T >; D also.

In table x the rate of growth in different stages are furnished to draw confiirmative conclusions about the longivity of the TxD Palm,

TABLE X

Stages of growth.	Description.	Mean value for total population under study.		
		Tx D	Tall	Dwarf
1st 9 yenr (1-9 years)	Total height attained.	183.8 cms	158.7 cms.	111.4 cms.
	Rate of growth per year.	20.43	17.63	1238
10-14 years	Total linear growth attained in 5 years.	173.6	159.0	55.50
	Rate of linear growth per year	34.72	31.8	11.10
15-19 years	Total growth attained in 5 years	107.53	93·5	57.3
	Rate of growth per year.	21 50	18.7	11.46
20. 24years	Total growth in 5 years	91.6	90,8	54.6
	Rate of growth per year	18.32	18.16	10.92

In TxD thequantum of linear growth for 5 years periodss and the rate ofgrowth in such stages are almost equal to that of tail. Great disparity is seen between I x D and Dwarf in the respect. So the inheritance and inclination of T x Din this case is more towards 'Tall' which forms more confirmative data to depict the tall growing habit and longivity of the hybrid. The histograph (No. 3) shows that quantum of growth and rate of growth of T x D in all stages is almost similar to that of Tall. So the inclination is towards tall and ensures tall habit and longivity in this hybrid.

Discussion

Hybridisation is an important lint of crop improvement in Agriculture and very good results are attained in case of Maize. Ever since Jack (1929) had mentioned about the occurance of Tall X Dwarf by natural crossing between Tall and Dwarf races in coconut, coconut improvement in this line were attempted. Thus in 1932 first generation hybrid was produced at Coconut Research Stations, Kasargode in India and the hybrid materials were planted on a large scale at the Agricultural Reserch Station, Nileshwar II in 1934-36, The plantation is 25 years old and this is the first and oldest plantation of its kind in India.. Based upon the proved hybrid vigour in nursery stage (Rao and Koyamu 1952) and in young, 63 months old plantation (John and Narayana 1943), large scale production and distribution of hybrids to public were taken up. Because ofthe spcial feature to perennial nature and time lag in coconutf the authors cold not study about the habit of bearing longivity of palm, yield characters etc, and these were only anticipated actors til] recently.

The subject matter of the paper is to compare the characters of T x D with its parental types and test whether it will prove better than W. C. tall, now grown on plantation scale.

Early flowering, early attainmemt of steady bearing peried, high yield, uniform bearing, good qualify nuts and long life are the desirable characters for an economic varity. Dwarf coconut, though an early bearer is deprived of uniform bearing and high yield. The popularly cultivated tall, though long lived, flowers late aed attains steady bearing stage late.

The early flowering character of Dwarf parent is inherited in T x D. Table III shows the mean age of first flowering of T × D, Tall and Dwarf and it is 4.80, 7.85 and 3.66 respectively. Thus a T x D garden owner is benefitted by 3 years bearing period than a Tall plantation owner.

Attainment of steady bearing period is also a most important factor since the garden owner gets a regular income only after the tree starts yielding uniformly. The Dwarf, attains the period in the immediate year after first flowering. Tall takes a few more years. This is generally due to the following factors.

I) Production of spathes only at greater interval, 2) Production of barren spathes, 3) Poor female flower production, 4) Poor settingpercentage.

Referring to several authors, Menon and Pandalai (1958), have concluded that full bearing from a Tall plantation could be expected only 20 to 25 years after its establishment.

Table IV presents the steady bearing age of T x D, Tall and Dwarf under study and the mean age is 7.92, 14.4 and 5.00 respectively. Thus the hybrid has inherited the desirable character of Dwarf and attains the steady bearing period at a favourably lower age. In other words the T X D planter is benefitted by extra yield in 7 steady bearing years, than Tall. Not only that the Tall garden owner loses the income for 7 years but also he spends for cultivation and manuring of the young tall plantation for all these years. The age range for attainment of steady bearing period in T x D and Tall are 6-13 and 7-24 years respectively.

Tables III and IV show that the T x D garden owner gets regular income from 7th year after planting as the trees come to flowering in 4th year and attains steady bearing by 7th year, while Tall garden owner gets regular income only 14 years afterplanting-

The yield of nuts is the most crucial factor to judge economic nature of the tree. Table V presents the annual mean yield for all 40 trees and mean yield per tree in all the ages of the plantation. It could be seen that TxD has given the maximum annual mean yield for all 40 trees and mean yield per tree (30.68) than the parental types even though Dwarf has given the maximum mean yield during its early bearing period. The tall variety which is in the first quarter of its life period and attains late flowering and late steady bearing period has given the least mean annual yield for the period, per tree.

One interesting feature to be noted is the bearing habit. The mean yield per tree per year for the period (till 24th year) of TxD Tall and Dwarf are 30.68, 5.15 and 11.28 respectively. The age at which maximum and minimum mean yield given by each variety is furnished below.

Variety,	Maximum		Minimum	
	Mean yield.	Age.	Mean yield.	Age.
TxD	44.02	20	0.8	5
Tall	11.45	24	0.3	7
Dwarf.	19.66	11	0.66	14

The graph 1, represents the mean yield curves of TxD (curve A) Tall (curve B) and Dwarf (curve C) for the period. From the graph and table furnished above it could be seen that in TxD and Tall the yield is increasing with the age and maximum yield is given in later years and least in early ages. But in Dwarf the maximum yield is obtained in early age and least yield in later ages, and the yield diminishes with age, especially in the third quarter of its life period. The similarity in yielding habits of Tall and TxD is an indication of the longivity of TxD like that ofTall. Just like the tall, the yield in TxD gradually rises with the age which shows that the tree is still in its early stage of life,

On examination of the graph 1, it could be noted that the rise and depression of curve in consecutive ages are predominant in Dwarf indicating the alternate bearing habit, while it is not so prominant in case of tall and T x D (curves A & B)

In table VII the annual yield of best yielding tree in the lot of TxD, Tall and Dwarf under study are given, The graph *2,* represents the yield curves of T xD (A) Tall (B) add Dwarf (C). The low yield obtained in lean years due to the irregular habit of

bearing in T × D, is compensated by the very high yield in the consecutive years and it brings up the mean yield Co level of high yielding palms. This may be taken as an indication to that TxD is not alternate in its bearing habit, but, only irregular as in case of Tall.

But in Tall, the low yield *in* lean years is not compensated fully. In case of Dwarf annual yield is comparatively low and intervened by more number of lean harvests. This reduces the mean annual yield of the tree. However the total yield till the 24th year and mean yield during bearing period in T × D, Tall and Dwarf are 1298, 375. 261 and 72.1, 22.0, 13.05 respectively. These trees were raised from best quality seedling selected from the nursery on the same nursery index,. This being the case the high total yield and mean yield of the TxD is evidently due to the hybrid vigour of the progeny.

Thus it is clear from the table V and VII and graph 1 and 2 that T X D is much superior to its parental type in respect of annual yield and similar to Tall in bearing habits. This will enable the cultivator to get a higher net return! from T × D plantation than from Tall plantation.

In a plantation there will be trees of different yield capacities viz poor, medium and high yielders adjudged on their mean annual yield. An elite plantation should always consist of a higher percentage of trees belonging to high and and medium yield groups Table VI presents the classification of trees under study in this line. It is seen that T × D variety have 50% in medium yield group and 50% in poor yield group while Tall and Dwarf have all the trees in poor yield group. In tall the condition may vary little with the age, as the trees are now in the first quarter of its life period only. The progenies now under study are obtained from parents of similar performance, have undergone same method of selection in the nursery and are grown under identical conditions. Hence the difference in yield group classification now exhibited Is due to genetic make up of the variety. Of course the general depression in yield in all the varieties may be due to the low fertility of the soil in which they are grown. Though a relatively better performance is attained in a fertile soil, the trees in each variety will occupy the same relative position. Menon and Pandalai (1958) after referring to this aspect of study conducted on a population of 1400 typica trees, have cocluded that the poor medium and high yield groups trees found to occupy the same relative position in spite of the fact that they are found to respond differentially to better plantation management. T × D will always maintain the relative position and the superiority over its parental types even in better soa types and plantation management, and would ensure a larger number of population ofbetter yielders which automatically increase produc;ion and per capita income of the cultivator.

Persual of performance of individual trees under study has shown that there are certain trees which flower late and bears late and do not possess the good qualities met with in T x D. Even though the percentage of such trees are negligibly small, it opens a new line of argument that there can be an " optimum parental combination". Early in 1937, Patel has stressed for the observation of optimum parental combination in hybridisation and opined that the poor

progenies are the results of incompatible parental combinations. Research in this line has already started at the Agricultural Research Station, Nileshwar as early as to Spot out the parental characters leading to incompatibility, so that such parents can be eliminated and occurence of such odd trees, of poor performance also can be eliminated from T x D collections in future. However occurence of such trees never deprives the T X D variety, since we come accross several plants of poor peeformance even in well maintained Tall plantation raisd from best selected seedlings in the nursery.

Apparently leaf and stem characters are not important factors for an economic plantation, but it helps a lot in assessing the yield, habit of bearing and longivity of the palm.

Table VIII presents the data for total leaves produced, number of functioning leaves on the crown and rate of production of leaves in T x D, tall and Dwarf. Total number of leaves so far produced and number of functioning leaves on the crown (1960 data) for T x D, Tall and Dwarf are 304.87, 245.37, 321,33 and 27.15, 20.02, 24.00 respectively. In both the cases, T x D is superior to Tall but inferrior to Dwarf, in case of total leaf production. The quality and length of leaf of TxD is much superior to Dwarf and almost equal to the tall. This again is a desirable character met with in T x D, as coconut leaf is alo a product of economic importance to the cultivators. Generally coconut leaves are also cut from the tree during months of lean harvests (October-December). The plaited coconut leaves commonly used for thatching houses fetches a good price and forms additional income to the cultivators. As functioning leaves and rate of production of leaves are more in T x D, more number of leaves can be cut from a T x D, tree than from Tall Tree.

Mean rate of production of leave in TxD is 12.91 while it is 10.00 and 14.5 in Tall and Dwarf respectively. Thus it is much superior to tall in this respect also. Liayanoge (1956) has positively correlated the rate of production of leaf to the production of inflorescence at shorter intervals culminating to high annual yield. High yield of TxD is thus confirmed by the leaf characters also.

The stem characters such as, girth, total height and rate of liner growth of all the three varieties are presented in table IX.

The mean girth of stem of T x D is 65 cms. while that of Tall and Dwarf is 67.3 and 52.3 cms. respectively. The girth of T x D is almost equal to that of Tall and differs much with that of Dwarf.

The mean total height attained by T X D is 52S cms. while it is 513,75 cms and 290 cms for Tall and Dwarf respectively. In case of total height, T x D is superior to Tall and Dwarf but the height of tall is almost equal to the height attained by T x D, The total height of Dwarf is a only just half the height of T x D.

With regard to rate of growth Tall is superior to T x D and Dwarf. Mean rate of growth for T x D is 9.72 cms. while it is 11.15 cms. and 6.66cms. respectively for Tall and Dwarf. The difference in rate of growth between TxD and Tall is less than the difference between that of TxD and Dwarf. Thus in this case also the inclination of i D is towards tall and differ widely from Dwarf.

Patel (1938) has studied a 15 year old plantation and correlated growth of stem with the age and concluded that there is a **graddual** reduction in the vertical growth of the stem as the tree advances in age. To have a much clear idea about the rate of growth in TxD in different stages, the first 9 years period is taken as 1st stage and the remaining part is divided into stages of 5 years period. Data pertaining to T x D Tall and dwarf are presented in table X for comparative study. In case of TxD and Tall maximum rate of growth is observed in 10–14 years, while in Dwarf maximum rate of growth is seen in 15-19 years period.

Rate of growth in tall in all stages seems almost equal to that of TxD whereas in Dwarf the rate of growth is far below and widely differs from that of T x D.

The histograph No. 3 presents a **pictorial** representation of total vertical growth and rate of growth of all the three varieties in different stages. The close similarity in girth rate of growth and total vertical growth of Tall and TxD in all stages are more confirmative data to prove the inheritance of Tall growing habit and **longivity** of Typica in TxD.

It is thus proved that TxD is an economic hybrid variety fit for large scale plantation, by virtue of the early bearing habit, early attainment of steady bearing period, high annual yield, long life indicated by analysis of growth habit and other characters, and availability of larger percentage of trees belonging to better yield groups. All conditions including the female **parental** performance being equal, the superior **charactets** exhibited by the T × D is only due to the hybrid vigour, which will be maintained in all sorts of soil and plantation management. Because of the availaibility of limited number of Dwarf trees, the data presented for Dwarf could be taken only for comparative purpose. Rao and **Koyamu** (1952) have declared Dwarf as uneconomic for a plantation after studying larger number of population.

SUMMARY

Hybridisation in coconut was done in 1932 with a view to combine the economic characters of Dwarf, i.e. early bearing, early attainment of steady bearing period with the economic characters of tail scuh as high yield, nut characters and long life. The hybrid so produced were studied for hybrid vigour in nursery stage by Rao and Koyamu (1952) and after in the age of 63 months by, John and Narayana (1943) Hybrid materials selected from the nursery were planted on a plantation scale in 2 acres plot at Nileswar II station, along with the natural progenies of its parental types for purpose of comparative study.

Detailed comparative study made in this paper has helped to spot out the following desirable characters in TxD and proved its hybrid vigour.

1) TxD bears earlier than Tall.
2) It attains steady bearing stages much earlier than Tall type.
3) Total annual yield is more in TxD than its **parental** types.
4) Though irregular bearing is exhibited by certain trees, the lean harvests are compensated by the very high yields in subsequent years and yield status is maintained in the long run. Irregular bearers are common in Tall. variety **also.**

5) The percentage of poor yielding palms, in TxD plantation raised by selected seedlings is much lower than the percentage ordinarily observed in tall plantation raised in same line.
6) Functioning leaves and rate of leaf production are more in TxD than the Tall variety and hence remuneration from sale of leaves is also more
7) Detailed study of stem characters, rate of growth and yield characters have given indications to the long life of the plain almost similar to that of Tall.

According to John and Narayana (1943) the copra content and oil content of TxD are 165 gm. and 70% and that of its original parent tall, they are 206.6 gm. and 71% respectively. According to Satyabalan (1956) the copara content and oil percentage of TxD is 8.8 oz. and 71% while that of Tall is 6.0 oz. and 72% respectively. Quality of copra is good in both case. So no marked difference is seen in this processed raarke table produce also.

All these factors contribute to prove superiority of TxD over its parental types. Of these. Dwarf (male parent) has been declared as uneconomic for a plantation after studying a larger population by Rao and Koyamu (1952). Tall (female parent) though a late bearer is recongnised for other economic characters and is grown popularly In the light of various characters dealt with in detail, T xD can be safety recommended as a profitable variety sutiable for large scale plantation.

This favorable conclusion leads to another question. How far this first generation hybrids could help in coconut improvement?". Considering the low density of population (55-60 trees per acre) and longivity of the palm this line of breeding can go a long way in coconut improvement. Because of these peculiar feature itself. the area once brought under this improved variety needs attention only at the stage of underplanting, i.e., ordinarily after 65-65 years. So fresh production of seed materials could bring more and more fresh area under this improved variety.

Research is in progress at Nileshwar station to find out how far the hybrid vigour is exhibited in the progenies raised from the open pollinated nuts of these hybrids, and seggregants to parental types could be eliminated by selection in the nursery *if* this line of selective planting is successful, the laborious process involved in artificial pollination could be favoided This is an item yet to be found out and hence the tested and proved line of production of hybrid materials holds good for the present.

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