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PROGRESS REPORT

PROGRESS REPORT NO. 4

(NOVEMBER, 1987 - APRIL, 1988)

COLLECTION AND UTILIZATION OF TAMARIND GERMPLASM

A RESEARCH PROJECT

GRANT NO. 936-5542-G-00-6026-00

SUBMITTED BY

DR.SUMRIT FEUNGCHAN
PROJECT LEADER

FACULTY OF AGRICULTURE
KHON KAEN UNIVERSITY
KHON KAEN 40002, THAILAND

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Project Profile

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Project Title : "Collection and Utilization of Tamarind Germplasm."

Project Leader : Dr.Sumrit Feungchan

Organization : Department of Plant Science
Faculty of Agriculture
Khon Kaen University
Khon Kaen 40002. Thailand

Co-investigators : Mr.Taweekiet Yimsawat
Mr.Sorot Chindaprasert
Mr.Pitool Kitpowsong

Project Consultants :

Authorized Officer : Dr.Somporn Bothinam MD.

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1. Background / Introduction

The research in this period emphasizes on recording Tamarind Accession Data based on IBPGR Tropical Fruit Descriptors in order to know the detail of their characteristics. Pod yield data and chemical composition of accessions are required to be the criteria for evaluation.

For the selection of biomass accessions has been conducted both in the field and containers because it is the possible criteria. The search for dwarf rootstock is still continued because it is expected to find the untended dwarf rootstock which is very useful for density growing. The study of Rhizobium in tamarind roots is in progress. The appropriate technology in tamarind production is needed.

2. Objectives

1) To evaluate the accessions.
2) To select and develop rootstock.
3) To prove the existence of Rhizobium in tamarind root.
4) To develop the technology of tamarind production.

3. Materials and Methods.

3.1 Testing of Germplasm

3.1.1 Biomass study

- To study the growth of plant both in containers and field.

The study on growth of plants in containers consist of 6 replications with 90 treatments and each treatment composes of 4 plants thus the population is 6x90x4 = 2160 plants. The

observation has been done monthly interval on growth rate, diameter of stem at 10 centimeters above soil level, height of plant, measuring in centimeters and also the number of branches recorded. Finally, the measuring of root length by Root Length Scanner, fresh and dry weight of the whole plant will be done at the end of the experiment.

All tamarind seedling specimens for biomass accession selection derived from seeds collected in various parts over the country. By assumption that each specimen might be different characteristics due to environmental condition and genotype.

The field experiment with Completely Randomized Block Design consists of 6 replications, 30 treatments, each treatment composes of 4 plants totally 2160 plants at spacing 2x2 meters.

The data collection of the field experiment has been done as mentioned above and the container experiment as well. The data will be used as the primary criteria for biomass accessions selection.After biomass accession obtained, the stomatal counting technique, angle of branches and NPK composition in leaf will be confirmedly investigated.

3.1.2 Fruit study

3.1.2.1 To observe the accession mother plant at the original site.

To study the performance of accession mother plant in pod yield for the preliminary evaluation of accession related to the Real Value of Pulp, size and shape of canopy, age of plant etc. by using IBPGR Descriptors for Tropical Fruits.

3.1.2.2 To test the accession grafted plants in the field

The grafted accession plants have grown in the testing plot with the Completely Randomized Block Design consists of 6 replications with 4 plants for each treatment, 42 and 20 treatments for sour and sweet types, respectively.

3.1.2.3 To analyse the chemical composition of pulp and seed of sour type accession.

The chemical analysis of shell, pulp and seed of accession has been carried out by the method of AOAC for supporting as the mean of accession selection.

3.2 Rootstock study

3.2.1 The search for dwarf rootstock

To test the classified seedling rootstocks based on stomatal grouping (Progress report No.3 page.13) in relation to the canopy size.

To search the untended dwarf phenotypic expression rootstocks. Fortunately we found the potential dwarf rootstock which will be studied on the morphological characteristics such as the canopy size, internode length and leaf area etc.

3.2.2 Chemical treatment for the production of dwarf rootstock

To control canopy size for the production of dwarf tamarind rootstock by using a certain inhibiting substances namely SADH, CCC, MH, and Paclobutazol. The seeds are treated by prolonged soaking method in solution for 6 hours at various concentrations viz. 1000, 2000, 3000, 4000, and 5000 ppm. The

number of 25 seeds are soaked in the different rates of above concentration and required 4 replications. The treated seeds are sown in the containers, then growth rate, canopy size, number of stomata etc. will be investigated at seedling stage.

3.3 Rhizobium study

3.3.1 To differentiate groups of Rhizobium form close proximity bacteria by the basis of biochemical characteristics.

Fifty nine isolated bacteria cultures similar to rhizobium cultural characteristics which were tested for some biochemical characteristics, utilization of citrate and carbohydrate, to differentiate from close proximity bacteria. Each isolated bacteria was streaked on Simmon's citrate agar slant (Appendix) and incubate at 30° C for 48 hours. The bacterial growth was observed. To test the utilization of carbohydrate, each isolated one was inoculated in phenol red broth base (PRBB) with four kinds of carbohydrates contained in separate tubes (Appendix). Acid and gas production in the media were observed after incubation at 30° C for 48 hours.

3.3.2 To comfirm the Rhizobium strains by inoculating onto tamarind seedling.

Microorganism preparation

Thirteen strains of the test Rhizobium were cultured on manitol medium (Appendix II) for 36 hours. Then, they were centrifuged to separate cell and supernatant at 5000 rpm. for 10 minutes. The supernatant was discard and the cell obtained at

the bottom of the tube was washed three times with phosphate buffer pH 7. The final cell solution was adjusted to appropiate concentration with the same buffer.

Tamarind seedling preparation

Tamarind seeds were sown in the 6 inch clay pot contained sterile soil. The sterile water (without nitrogen) was applied to the pot twice a day. After one month, leave only two seedlings in one pot, then they were ready for Rhizobium inoculation.

Rhizobium inoculation

Twenty five millilitres of each Rhizobium inocuium was poured in to tamarind pot. Fifteen seed pots were used per one strain of microorganism. The control was treated by phosphate buffer only. The height of the tamarind seedlings was measured every fifteen day interval after inoculation to observe growth.

3.4 Cultural practice and Demonstration.

3.4.1 To study the effect of plant regulators on widening the crotch angles of tamarind.

- To control the angles in branching by using the chemical substances with TIBA and BA at various concentrations viz. 25, 50, 75 and 100 ppm. Hence, the wide angles in branching normally give long straight lumber and large girth which will be useful for wood utilization (ref. Teak Improvement Center, Ngao, Lampang, Thailand, in Project Proposal.)

3.4.2 To study the effect of spacing on growth.

- To study the effect of the different spacing in order to find out the basic data on branching of plant for asexual propagation purpose.

Completely Randomized Block Design will be used with 3 replications and 3 treatments at spacing of 2x1, 2x1.5 and 2x2 meters.

3.4.3 To study the young leaf production for human consumption.

By foliar application with the substances namely Thiourea, Urea, Potassium nitrate, Ethephon and 2,4-D at the rate of different concentrations eg. 50, 100, 150, 200 and 250 ppm.

Completely Randomized Block Design with 5 replications 6 treatments and 20 plants per treatment will be used.

3.4.4 To study the change of pulp colour in storage.

The pulp colour will gradually change from the natural one to black when store in the room temperature. From this effect, the pulp quality is inferior and price is reduced. Hence, the experiment will be tried to overcome this problem by using the several mears as follow :-

1. Powdered salt : 5, 10, 15, 20, 25 and 30 %
2. Steam : 15, 20 and 30 minutes.
3. Sodium metabisulphite 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 ppm.
4. Sun dry : 3 days.
5. Hot air incubation : 40°, 45°, 50°, 55°, 60°, 65° and 70° C for 24 hours.
6. Cold storage : 5° and 0° C.

4. Results/ Discussion/ Tables :

4.1 Testing of Germplasm

4.1.1 Biomass study

Table 1 Ranked Order of Biomass accessions in the field (Duncan's Multiple Range Test, α = 0.01)

Ranked order	Accession no.	Score: Height (cm)	Score: Width (cm)	Score: Length(cm)	Total Score
1.	77	1	1	2	4
2.	81	4	3	1	8
3.	30	3	2	6	11
4.	20	8	4	4	16
5.	10	2	7	11	20
6.	11	5	8	13	26
6.	78	7	14	5	26
8.	31	6	9	12	27
9.	76	10	15	3	28
10.	16	9	5	15	29
11.	35	14	10	8	32
12.	15	17	11	17	35
13.	29	11	6	27	44
14.	9	13	13	26	52
14.	27	19	24	9	52
16.	18	18	18	17	53

Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
17.	17	21	12	22	55
17.	32	16	16	23	55
19.	25	29	17	14	60
20.	87	23	23	16	62
21.	83	26	28	10	64
22.	1	12	30	24	66
23.	41	15	19	33	67
24.	67	32	22	19	73
25.	37	28	33	18	79
26.	38	20	25	35	80
27.	14	36	20	31	87
27.	89	22	44	21	87
29.	8	33	26	29	88
30	40	27	21	42	90
31.	36	25	32	43	100
32.	79	35	27	40	102
33.	80	38	34	34	106
34.	84	45	39	25	109
35.	24	30	36	48	114
36.	42	24	37	59	120
37.	19	37	29	56	122
37.	43	50	42	30	122
39.	22	48	31	44	123

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Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
40.	12	41	40	46	127
40.	75	39	52	36	127
42.	45	49	45	37	131
43.	34	44	41	47	132
43.	71	66	38	28	132
45.	86	46	49	39	134
46.	26	52	35	52	139
47.	3	31	43	66	140
48.	21	43	50	53	146
48.	74	55	53	38	146
50.	39	54	48	54	156
51.	70	64	57	41	162
52.	5	51	51	62	164
53.	13	40	55	70	165
53.	33	56	59	50	165
55.	4	34	65	67	166
56.	85	63	46	58	167
57.	28	69	54	45	168
57.	62	65	71	32	168
57.	72	60	47	61	168
60.	56	61	60	49	170
61.	60	47	68	57	172
62.	57	62	63	51	176

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Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
63.	47	78	80	20	178
64.	23	59	62	60	181
65.	7	53	58	77	188
66.	2	42	67	81	190
67.	6	68	61	71	200
68.	61	82	56	64	202
69.	69	67	70	68	205
70.	49	58	73	75	206
71.	82	57	83	69	209
71.	88	72	72	65	209
73.	65	77	78	55	210
74.	54	73	66	72	211
75.	90	75	76	63	214
76.	44	70	74	76	220
76.	48	71	75	74	220
78.	53	76	69	82	227
78.	59	83	64	80	227
80.	52	74	77	79	230
81.	58	81	82	73	236
82.	46	80	79	78	237
83.	51	84	81	84	249
84.	68	79	84	89	252
85.	55	86	85	86	257

Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
85.	63	85	89	83	257
87.	50	87	88	87	262
87.	66	90	87	85	262
89.	64	89	86	88	263
90.	73	88	90	90	268

Table 2 Ranked order of Biomass accessions in the container (Duncan's Multiple Range Test, α = 0.01)

Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
1.	49	1	1	1	3
2.	47	7	3	4	14
3.	50	5	7	8	20
3.	74	2	9	9	20
5.	60	3	12	6	21
6.	58	8	10	10	28
7.	46	4	26	2	32
7.	79	9	8	15	32
9.	43	6	6	30	42
10.	51	19	11	17	47
11.	35	10	15	24	49
12.	40	13	36	3	52
13.	52	22	25	7	54
13.	57	16	22	16	54
15.	72	20	23	12	55
16.	37	17	29	14	60
17.	14	41	17	5	63
18.	33	36	16	13	65
19.	90	15	5	54	74
20.	18	45	13	18	76
20.	31	25	32	19	76

Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
20.	61	11	37	28	76
23.	84	46	20	11	77
24.	87	51	2	25	78
25.	44	18	39	23	80
26.	70	28	21	35	84
27.	32	30	30	26	86
28.	88	37	4	48	89
29.	66	43	14	36	93
30.	73	32	35	29	96
31.	59	49	28	20	97
32.	63	31	27	43	101
33.	86	12	33	58	103
34.	77	66	19	22	107
34.	45	33	53	21	107
36.	62	29	43	41	113
37.	75	23	38	55	116
38.	5	27	41	49	117
39.	36	26	61	31	118
40.	26	42	51	27	120
41.	78	63	18	42	123
42.	69	35	45	45	125
43.	6	47	31	50	128
44.	68	56	47	32	135

Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
45.	65	50	40	46	136
46.	85	38	44	56	138
47.	12	21	79	44	144
48.	8	14	71	64	149
49.	24	44	74	34	152
50.	76	61	55	38	154
51.	71	53	46	57	156
52.	20	57	62	40	159
53.	54	24	50	57	161
54.	89	34	49	79	162
55.	1	52	60	51	163
56.	11	60	64	39	163
57.	41	64	42	61	167
58.	4	40	73	59	172
59.	42	65	58	53	176
60.	15	48	68	62	178
61.	25	54	65	60	179
62.	28	82	67	33	182
62.	48	55	57	70	182
64.	80	84	24	75	183
65.	30	39	77	68	184
66.	56	67	54	65	186
67.	53	78	59	52	189

Ranked order	Accession no.	Score			Total Score
		Height (cm)	Width (cm)	Length(cm)	
68.	21	59	70	63	192
69.	38	81	75	37	193
69.	83	79	14	80	193
71.	7	71	52	72	195
72.	19	74	76	47	197
73.	81	70	48	82	200
74.	16	72	63	67	202
75.	67	58	66	81	205
76.	29	69	78	71	218
76.	64	62	72	84	218
78.	10	68	84	69	221
78.	55	75	80	66	221
80.	39	77	82	74	233
81.	82	89	56	89	234
82.	17	85	69	83	237
83.	34	80	83	76	239
84.	9	83	81	78	242
85.	22	73	86	86	245
86.	2	87	88	73	248
86.	3	86	85	77	248
86	23	76	87	85	248
89.	13	88	89	88	265
90.	27	90	90	90	270

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All these samples will be packed in transparent and opaque containers and observed the change of pulp-colour with spectrophotometer Model. Shimazu UV - 240. The design of experiment is Completely Randomized Block Design with 3 replications, each treatment consists of the 6 samples and each sample weight is 250 grams.

From table 1 and 2 the classification of Biomass Accession based on Ranked Order, it was found that there is the great difference on total score which derived from the growth characters eg. height, width and length of canopy. The result showed that the low score represent the vigorous plant while the high score is dwarf one.

The result of field and container experiment is highly contrast on Ranked Order. Since the heredity and environmental factors might cause the variation from seed to seed. It is noticed that the Biomass accessions in containers which arranged in closed spacing that causes high competition in community such as the Biomass accession no. 19 may be suitable for closed planting in biomass production.

4.1.2 Fruit study

4.1.2.1 To observe the accession mother plant at the original site.

Table 3 Pod Yield of Sour type accession

Accession No.	Source of Collection	Yield (kg.)
86 - 2 - 13 - 001	Sakon Nakhon	1.250
86 - 2 - 13 - 019		53.000
86 - 2 - 13 - 018		65.000
86 - 2 - 13 - 020		5.900
86 - 2 - 13 - 015		120.000
86 - 2 - 13 - 008		30.000
86 - 2 - 13 - 002		0.500
86 - 2 - 13 - 009		27.000
86 - 2 - 13 - 017		73.000
86 - 2 - 13 - 001		731.000
86 - 2 - 13 - 004		51.500
86 - 2 - 13 - 005		1.000
86 - 2 - 13 - 014		39.000
86 - 2 - 08 - 038	Mukdaharn	3.500
86 - 2 - 08 - 028		0.200
86 - 2 - 08 - 083		13.000
86 - 2 - 08 - 183		15.000
86 - 2 - 08 - 016		316.000
86 - 2 - 08 - 095		15.000
87 - 2 - 08 - 003		14.000
87 - 2 - 08 - 027		2.000
87 - 2 - 08 - 025		20.000
87 - 2 - 08 - 014		0.800
87 - 2 - 08 - 023		2.000
87 - 2 - 08 - 005		8.500

Accession No.	Source of Collection	Yield (kg.)
87 - 2 - 17 - 021	Ubon Ratchathani	36.000
87 - 2 - 17 - 022		56.000
87 - 2 - 17 - 011		16.280
87 - 2 - 17 - 009		5.400
87 - 2 - 17 - 016		0.720
87 - 2 - 17 - 008		84.450
87 - 2 - 17 - 026		226.000
87 - 2 - 01 - 035	Nakhon Ratchasima	2.200
87 - 2 - 09 - 017	Yasothon	60.000
87 - 3 - 20 - 002	Samut Sakhon	-
87 - 4 - 13 - 003	Satun	100.000
87 - 2 - 01 - 005	Kalasin	6.000
87 - 1 - 02 - 001	chiang Rai	80.000
87 - 1 - 02 - 002		-
87 - 1 - 02 - 003		95.000
87 - 1 - 02 - 004		120.000
87 - 1 - 02 - 005		100.000

From Table 3 showing the mature pod yield of accession that collected from the whole country in the year 1987-1988. The yield of each accession is quite different due to the climatic conditions and genetic factors. Therefore, the yield evaluation should be repeated in the same locallity

4.1.2.2 To test the accession grafted plants in the field.

The grafted accession plants already have been grown in the experimental plot for further observation.

4.1.2.3 To analyse the chemical composition of pulp and seed for sour type accession

Table 4 Chemical analysis of mature pod.

	% Sugar			% Starch			% Tannin			% Tartaric acid			% Protein		
Accession No.	Pulp	Shell	Seed	Pulp	Shell	Seed	Pulp	Shell	Seed	Pulp	Shell	Seed	Pulp	Shell	Seed
87-2- 7-021	1.7340	0.1275	0.0160	[illegible]	0.0168	0.0904	0.0054	0.0205	0.0023	[illegible]	1.0707	0.2419	3.5273	3.8730	16.9040
87-2- 7-022	1.5450	0.1458	0.0191	0.0310	0.0365	0.1603	0.0032	0.0055	0.0013	[illegible]	0.3271	0.3192	[illegible]	3.6310	17.6460
87-2- 7-011	1.2737	0.1021	0.0193	0.0981	0.0253	0.1619	0.0213	0.0014	0.0105	[illegible]	[illegible]	0.1343	[illegible]	3.0170	15.6650
87-2- 7-003	1.2863	0.1653	0.0432	0.0145	0.0329	0.1062	0.0024	0.0037	0.0024	3.4481	0.9281	0.2415	[illegible]	3.6580	17.7110
87-2- 7-016	1.5821	0.1095	0.0111	[illegible]	0.0263	[illegible]	0.0378	0.0023	0.0014	[illegible]	0.6046	0.1325	3.8640	5.0930	16.2540
87-2- 7-008	1.5024	0.2196	0.0837	0.0191	0.0353	0.3971	0.0029	0.0023	0.0010	2.8872	1.0177	0.2241	2.0560	3.1380	15.7890
87-2- 7-026	0.9980	0.0979	0.0536	0.0503	0.0301	0.2570	0.0043	0.0074	0.0006	3.2883	1.0786	0.2267	2.6690	3.0330	16.2030

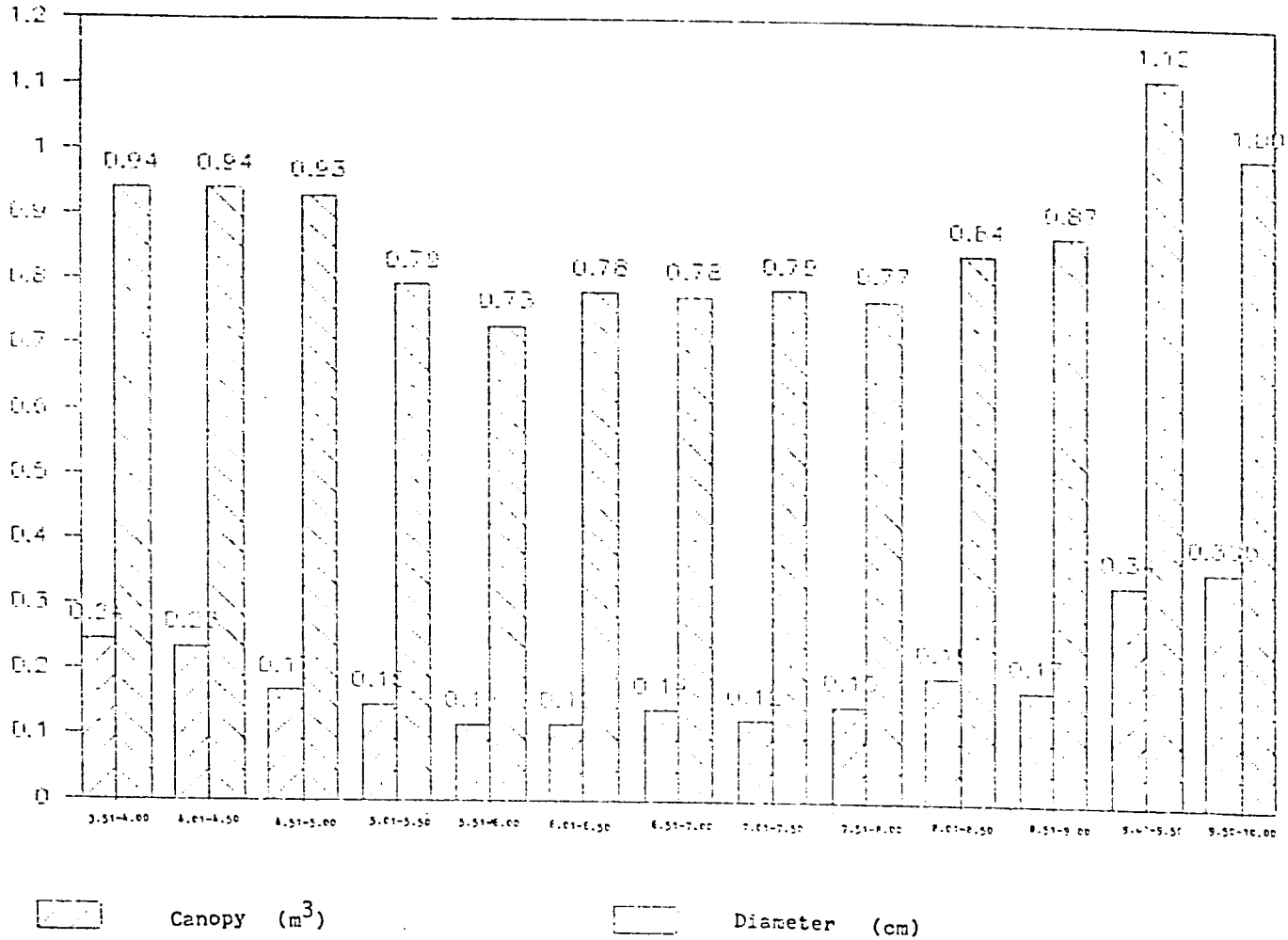
From table 4 showing the chemical composition of pulp, shell and seed of some accessions, the result has indicated a great variation in term of percentage of sugar, starch, tannin, tartaric acid and protein. This analysis will be used for supporting the selection of superior accession.

4.2 Rootstock study

4.2.1 The search for dwarf rootstock

4.2.1.1 To test the classified seedling rootstocks based on stomatal grouping in relation to the canopy size.

Fig 1 Canopy and diameter of rootstock.
in relation to number of stomata.
(10 months old plants)



From Fig.1 it has shown that there is no difference on growth characters eg. canopy and stem diameter of the rootstocks at early stage based on the number of stomata. However, the further observation should be done in the field.

4.2.1.2 To search the untended dwarf phenotypic expression rootocks.

Table 5 Comparison of Morphological Characteristics on Dwarf Rootstock and Accession

Plant No.	Girth (cm)	Canopy * (m3)	Age (yrs)	Internode Length ** (cm)	Leaf area/100 leaves*** (cm2)
87-2-17-021 Control	322	9180.00	45	1.705	110.82
Dwarf No 1	77	149.76	30	1.491	79.86
Dwarf No 2	73	274.40	20	1.833	95.28

* Measured at 100 centimetres above ground level

** Internode Length from an average of 10 shoots.

*** Automatic Areameter Model No. AAC-400 Hayashi Denkon Co., LTD.

From Table 5 showing the morphological characteristics of the Accession No. 87-2-021 plant as control to compare with the Dwarf Rootstock No. 1 and 2, the result indicated that canopy, internode length and leaf area of Dwarf No.1 are quite difference. However, the further study in anatomical characters eg. stomatal country, epidermall cell, palisade cell etc. in order to prove the unique dwarf rootstock characters.

4.2.2 Chemical treatment for the production of dwarf rootstock

Table 6 Effect of Chemical Substances on Growth of Seedling*

Plant Growth Substances	Concentration (ppm)	Height (cm)	Width (cm)	Length (cm)	Canopy (cm^3)	Lenght of node (cm)	Diameter (cm)
Control	0	71.33 ABC	19.33 ABC	21.00 ABC	29121.33 ABC	1.21 ABCDE	0.64 ABC
SADH	1000	71.00 ABC	23.00 A	23.00 A	37634.67 A	1.29 ABC	0.61 ABCDE
	2000	75.00 AB	20.33 AB	22.00 AB	33646.67 AB	1.19 BCDE	0.64 ABC
	3000	65.67 ABCDE	19.67 AB	18.67 ABCD	25208.67 ABCDE	1.19 DEFG	0.60 ABCDE
	4000	66.33 ABCDE	20.00 AB	18.00 ABCDE	25228.67 ABCDE	1.21 ABCDE	0.64 ABCD
	5000	65.67 ABCDE	20.33 AB	17.33 ABCDE	23198.67 ABCDE	1.20 BCD	0.64 ABC
CCC	1000	62.67 BCDEF	16.00 BCDE	18.67 ABCDE	19161.67 BCDE	1.27 ABC	0.57 BCDEF
	2000	64.00 ABCDE	13.67 DE	12.67 D	11226.00 DE	1.27 ABC	0.56 DEFG
	3000	66.33 ABCDE	16.67 BCDE	17.00 ABCDE	18878.00 BCDE	1.29 ABC	0.55 EFG
	4000	61.33 CDEF	12.67 E	13.33 CD	10388.00 E	1.29 ABC	0.55 EFG
	5000	55.67 DEF	15.33 BCDE	14.33 BCD	15931.00 CDE	1.34 A	0.52 FG

Plant Growth Substances	Concentration (ppm)	Height (cm)	Width (cm)	Length (cm)	Canopy (cm^3)	Lenght of node (cm)	Diameter (cm)
MH	1000	77.00 A	18.67 ABCDE	18.67 ABCD	27714.00 ABCD	1.23 ABCD	0.64 ABCD
	2000	67.67 ABCD	14.00 CDE	15.67 ABCD	15007.67 CDE	1.16 CDEF	0.62 ABCDE
	3000	56.67 DEF	15.67 BCDE	18.00 ABCD	16012.33 CDE	1.19 BCDE	0.61 ABCDE
	4000	58.33 CDEF	17.00 BCDE	19.00 ABCD	18641.33 BCDE	1.33 AB	0.65 AB
	5000	56.00 DEF	16.33 BCDE	18.33 ABCD	17174.33 BCDE	1.15 CDEFG	0.57 CDEF
Pac	1000	53.67 EF	17.00 BCDE	19.33 ABCD	17596.00 BCDE	1.08 EFG	0.66 A
	2000	41.00 GH	20.67 AB	20.67 ABC	17546.67 BCDE	0.93 I	0.57 BCDEF
	3000	38.67 GH	19.00 ABCDE	19.67 ABCD	14862.00 CDE	0.94 HI	0.48 G
	4000	36.00 H	16.33 BCDE	15.67 ABCD	9419.00 E	0.06 FGH	0.50 FG
	5000	50.33 FG	17.33 BCDE	18.00 ABCD	15809.33 CDE	1.03 GHI	0.58 ABCDEF

* Duncan's Multiple Range Test, α = 0.01

From Table 6 the chemical treatment for the production of dwarf rootstocks by using a certain inhibitors viz. SADH, CCC, MH and Paclobutrazol effected highly significant on growth characters. Especially both CCC and Paclobutrazol trend to induce dwarfness. However, the field experiment should be observed.

4.3 Rhizobium study

Table 7 The average heigth of tamarind seedling inoulated with test Rhizobium.

Microorganism	Average height of tamarind seedlings		Increasing heigth
	0 day (cm)	41 day (cm)	(cm)
1	15.41	23.05	7.64
2	16.00	23.26	7.26
3	15.82	22.89	7.07
4	16.44	23.02	6.58
5	16.24	23.82	7.58
6	15.33	22.17	6.84
7	16.09	23.26	7.17
8	17.02	23.80	6.78
9	16.70	22.45	5.75
10	16.32	23.22	6.90
11	15.50	21.72	6.22
12	16.12	23.44	7.32
13	14.89	21.93	7.04
Control	16.12	22.81	6.69

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Fifteen out of the 59 isolated of bacterial cultures could not utilize citrate but could produce acid with out gas in phenol red broth base medium containing glucose, sucrose, lactose or mannitol. These characteristics belong to the genus Rhizobium according to Bergey's Manual of Systematic Bacteriology (Krieg and Holt, 1984). As this result, only 25% of cultures isolated from the root samples had the biochemical characteristics which were similar to Rhizobium group. It was too low to consider that they were the Rhizobium associating with tamarind roots. Thus, the 15 isolated bacteria were inoculated into the tamarind seedling grown in sterile soil lacking or having small amount of nitrogen for confirmation of the result.

It was found that the increasing height of the tamarind seedlings of the thirteen test Rhizobium strains and the control was not significantly different as shown in table 7.

From this result there was trace amount of nitrogen left in the sterile soil. The seedlings could utilize this element for growth which we could observe from the control seedlings. There was no characteristic of lacking nitrogen in the control pots. Our next experiment will be focused on inoculating of test Rhizobium on tamarind seedling grown in washed sterile sand absolutely lacking of nitrogen to confirm whether there are any differents happened between the test strains and the control. We also try to prove our test Rhizobium by inoculating on various kinds of bean seedling cultured on washed sterile sand to observed whether there are any nodules occurred.

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4.4 Cultural Practice and Demonstration

4.4.1 To study the effect of plant regulators on widening the crotch angles of tamarind.

Table 8 Effect of growth substances on angle of branches

Growth substance	Concentration (ppm)	Angle ( )
Control	0	70.909
TIBA	25	71.325
	50	72.851
	75	71.803
	100	72.942
BA	25	78.134
	50	76.060
	75	76.194
	100	74.856
test		NS
CV (%)		5.83

From Table 8 showing the effect of growth substances on the branch angle, found that there is no statistical difference in all kinds and concentrations of chemical. However, the treated plants should be transplanted from containers to the pot for further study on the angle of branches.

4.4.2 To Study the effect of spacing on growth

Table 9 The average number of branches, girth and height of plant 10 months after planting

Spacing (m)	No. of Branch	Height of Plants (cm)	Girth (cm)
2.0 x 1.0	6.920 [b]	37.980	1.86 [b]
2.0 x 1.5	10.260 [a]	41.970	2.15 [a]
2.0 x 2.0	9.700 [a]	38.320	1.93 [b]
Test		N.S	
CV (%)	9.87	6.07	4.39

From Table 9 the experiment on the different spacing of planting, it is found that the number of branches and girth of 2.0 x 1.5 meters spacing are highly significant from the others but there is no difference on height of plants.

5. Conclusion / Remark :

1. There is a great difference on growth characters of each biomass accession grown in the field and containers, might be utilized for biomass production in various planting systems
2. Soil and climatic condition influence to the pod yield of the mother plants at the original sites.
3. The chemical analysis of each accession indicates the difference.
4. One dwarf rootstock was found based on morphological characteristics that should be studied in other aspects to prove its dwarfness.
5. CCC and Paclobutrazol has tendency to control the canopy size.
6. No effect of chemical substances (TIBA and BA) on widening the crotch angles of tamarind at seedling stage.
7. The spacing of 2.0 x 1.5 meters produced more number of branches and larger girth.

6. Workplan for the Next Period:

6.1 Testing of Germplasm

6.1.1 Biomass study

- To study the growth of plant both in field and containers.

6.1.2 Fruit study.

- To observe the accession mother plants at the original sites.
- To test the accession grafted plants in the field.

- To analyse the chemical composition of leaf and pod of accessions.

6.2 Rootstock study

6.1.1 The search for dwarf rootstock.

- To search and test the untended dwarf phenotypic expression plant.

6.2.2 Chemical treatment for the production of dwarf rootstock.

6.3 Rhizobium study.

- To study the inoculation and isolation of Rhizobium from tamarind.
- To identify the Rhizobium from tamarind under Electron Microscope.

6.4 Cultural practice and Demonstration

- To study the effect of plant regulators on widening the crotch angles of tamarind.
- To study the effect of spacing on growth.
- To study the production of young leaf.
- To study the change of pulp colour in storage.
- To study the seed storage.

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Annex / Picture

Table 1 Detailed data of Biomass accessions in the field with statistical analysis (Duncan's Multiple Range Test, α = 0.01)

Ranked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession no.	Length (cm)
1.	77	76.04 A	77	69.83 A	81	64.50 A
2.	10	74.17 AB	30	68.83 AB	77	64.17 AB
3.	30	74.00 AB	81	68.83 AB	76	58.83 ABC
4.	81	71.00 ABC	20	68.00 AB	20	58.00 ABC
5.	11	68.50 ABCD	16	68.00 AB	78	57.50 ABCD
6.	31	68.33 ABCD	29	67.83 ABC	30	57.50 ABCD
7.	78	68.00 ABCD	10	67.17 ABC	15	56.17 ABCD
8.	20	67.83 ABCD	11	67.00 ABCD	35	54.67 ABCD
9.	16	67.67 ABCD	31	66.50 ABCDE	27	54.50 ABCD
10.	76	67.50 ABCD	35	65.17 ABCDE	83	53.00 ABCD
11.	29	67.00 ABCD	15	63.17 ABCDEF	10	52.83 ABCD
12.	1	66.83 ABCDE	17	63.00 ABCDEF	31	52.67 ABCD
13.	3	66.83 ABCDE	9	62.17 ABCDEFG	11	52.67 ABCD
14.	35	66.50 ABCDE	78	61.50 ABCDEFG	25	52.67 ABCD
15.	41	66.33 ABCDE	76	61.50 ABCDEFG	16	52.17 ABCD
16.	32	66.00 ABCDE	32	61.33 ABCDEFG	87	52.17 ABCD
17.	15	65.50 ABCDE	25	61.17 ABCDEFG	18	50.00 ABCD
18.	18	64.33 ABCDE	18	59.83 ABCDEFG	38	49.67 ABCD
19.	27	64.17 ABCDE	41	59.83 ABCDEFG	67	49.33 ABCD
20.	38	63.17 ABCDE	14	59.83 ABCDEFG	47	49.17 ABCD
21.	17	63.00 ABCDE	40	59.83 ABCDEFG	89	49.00 ABCD

Ranked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession no.	Length (cm)
22.	89	62.17 ABCDEF	67	59.33 ABCDEFG	17	47.33 ABCD
23.	87	62.00 ABCDEF	87	59.17 ABCDEFG	32	47.33 ABCD
24.	42	61.00 ABCDEF	27	58.33 ABCDEFG	1	47.17 ABCD
25.	36	60.33 ABCDEF	38	58.17 ABCDEFG	84	47.17 ABCD
26.	83	60.17 ABCDEF	8	57.17 ABCDEFG	9	47.00 ABCD
27.	40	59.83 ABCDEF	79	57.00 ABCDEFG	29	47.00 ABCD
28.	37	59.67 ABCDEF	83	56.83 ABCDEFG	71	46.17 ABCD
29.	25	59.33 ABCDEF	19	56.83 ABCDEFG	8	45.67 ABCD
30.	24	59.33 ABCDEF	1	56.67 ABCDEFG	43	45.67 ABCD
31.	9	58.83 ABCDEF	22	56.17 ABCDEFG	14	45.67 ABCD
32.	67	58.67 ABCDEF	36	56.00 ABCDEFG	62	45.33 ABCD
33.	8	58.33 ABCDEF	37	55.83 ABCDEFG	41	45.33 ABCD
34.	4	58.17 ABCDEF	80	55.67 ABCDEFG	80	45.17 ABCD
35.	79	58.00 ABCDEF	26	55.50 ABCDEFG	38	44.33 ABCD
36.	14	57.83 ABCDEF	24	54.67 ABCDEFG	75	44.33 ABCD
37.	19	57.67 ABCDEF	42	54.67 ABCDEFG	45	44.17 ABCD
38.	80	57.50 ABCDEF	71	53.83 ABCDEFG	74	44.17 ABCD
39.	75	57.00 ABCDEF	84	53.83 ABCDEFG	86	43.83 ABCD
40.	13	65.17 ABCDEF	12	53.33 ABCDEFG	79	43.83 ABCD
41.	12	56.17 ABCDEF	34	53.00 ABCDEFG	70	43.67 ABCD
42.	2	56.00 ABCDEF	43	51.67 ABCDEFG	40	42.83 ABCD
43.	21	56.00 ABCDEF	3	51.67 ABCDEFG	36	42.83 ABCD
44.	34	56.00 ABCDEF	89	51.50 ABCDEFG	22	42.50 ABCD
45.	84	56.00 ABCDEF	45	51.50 ABCDEFG	28	42.50 ABCD

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Ranked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession no.	Length (cm)
46.	86	55.80 ABCDEF	85	51.50 ABCDEFG	12	42.33 ABCD
47.	60	55.50 ABCDEF	72	51.00 ABCDEFG	34	42.33 ABCD
48.	22	55.17 ABCDEF	39	50.17 ABCDEFG	24	42.17 ABCD
49.	45	55.17 ABCDEF	86	46.67 ABCDEFG	56	42.00 ABCD
50.	43	55.17 ABCDEF	21	49.17 ABCDEFG	53	40.50 ABCD
51.	5	54.50 ABCDEF	5	49.17 ABCDEFG	57	40.33 ABCD
52.	26	54.33 ABCDEF	75	48.50 ABCDEFG	26	40.00 ABCD
53.	7	54.33 ABCDEF	74	48.33 ABCDEFG	21	39.67 ABCD
54	39	54.17 ABCDEF	28	48.33 ABCDEFG	39	39.33 ABCD
55.	74	53.67 ABCDEF	13	48.00 ABCDEFG	65	39.17 ABCD
56.	33	53.50 ABCDEF	61	47.83 ABCDEFG	19	39.17 ABCD
57.	82	53.50 ABCDEF	70	47.83 ABCDEFG	60	39.17 ABCD
58.	49	53.17 ABCDEF	7	47.50 ABCDEFG	85	39.17 ABCD
59.	23	53.00 ABCDEF	33	47.50 ABCDEFG	42	39.17 ABCD
60.	72	53.00 ABCDEF	56	47.17 ABCDEFG	23	39.17 ABCD
61.	56	52.83 ABCDEF	6	47.17 ABCDEFG	72	39.00 ABCD
62.	57	52.50 ABCDEF	23	47.00 ABCDEFG	5	38.83 ABCD
63.	85	52.00 ABCDEF	57	46.67 ABCDEFG	90	38.67 ABCD
64.	70	51.83 ABCDEF	59	46.17 ABCDEFG	61	38.33 ABCD
65.	62	51.83 ABCDEF	4	46.00 ABCDEFG	88	37.83 ABCD
66.	71	51.67 ABCDEF	54	46.00 ABCDEFG	3	37.67 ABCD
67.	69	51.50 ABCDEF	2	45.67 ABCDEFG	4	37.33 ABCD
68.	6	51.25 ABCDEF	60	45.67 ABCDEFG	69	36.83 ABCD
69.	28	51.00 ABCDEF	53	45.67 ABCDEFG	82	36.83 ABCD

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Ranked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession no.	Length (cm)
70.	44	50.33 ABCDEF	69	45.50 ABCDEFG	13	36.67 ABCD
71.	48	50.00 ABCDEF	62	45.50 ABCDEFG	6	35.50 ABCD
72.	88	49.50 ABCDEF	88	44.83 ABCDEFG	54	35.50 ABCD
73.	54	49.50 ABCDEF	49	43.33 ABCDEFG	58	35.33 ABCD
74.	52	49.33 ABCDEF	44	43.50 ABCDEFG	48	35.00 ABCD
75.	90	48.83 ABCDEF	48	43.17 ABCDEFG	49	34.83 ABCD
76.	53	48.67 ABCDEF	90	42.83 ABCDEFG	44	34.00 ABCD
77.	65	48.33 BCDEF	52	42.33 ABCDEFG	7	34.00 ABCD
78.	47	47.67 BCDEF	65	42.33 ABCDEFG	46	33.83 ABCD
79.	68	47.50 BCDEF	46	41.83 ABCDEFG	52	32.67 BCD
80.	46	47.33 BCDEF	47	41.83 ABCDEFG	59	31.50 CD
81.	58	47.17 BCDEF	51	40.17 ABCDEFG	2	30.17 CD
82.	61	47.17 BCDEF	58	40.17 ABCDEFG	53	29.83 CD
83.	59	46.00 CDEF	82	39.83 ABCDEFG	63	29.83 CD
84.	51	45.17 CDEF	68	37.50 ABCDEFG	51	29.67 CD
85.	63	43.67 CDEF	55	36.67 BCDEFG	66	29.58 CD
86.	55	43.00 DEF	64	35.50 CDEFG	55	29.00 CD
87.	50	39.83 EF	66	34.33 DEFG	50	28.83 CD
88.	73	39.83 EF	50	33.83 EFG	64	28.17 CD
89.	64	39.50 EF	63	32.33 FG	68	28.17 CD
90.	66	35.42 F	73	30.00 G	73	26.00 D

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Table 2 Detailed data of Biomass accessions in the field on ranked order

Ranked order	Accession no. Height	Width	Length
1.	77	77	81
2.	10	30	77
3.	30	81	76
4.	81	20	20
5.	11	16	78
6.	31	29	30
7.	78	10	15
8.	20	11	35
9.	16	31	27
10.	76	35	83
11.	29	15	10
12.	1	17	31
13.	9	9	11
14.	35	78	25
15.	41	76	16
16.	32	32	87
17.	15	25	18
18.	18	18	38
19.	27	41	67
20.	38	14	47
21.	17	40	89

Ranked order	Accession no. Height	Width	Length
22.	89	67	17
23.	87	87	32
24.	42	27	1
25.	36	38	84
26.	83	8	9
27.	40	79	29
28.	37	83	71
29.	25	19	8
30.	24	1	43
31.	3	22	14
32.	67	36	62
33.	8	37	41
34.	4	80	80
35.	79	26	38
36.	14	24	75
37.	19	42	45
38.	80	71	74
39.	75	84	86
40.	13	12	79
41.	12	34	70
42.	2	43	40
43.	21	3	36
44.	34	89	22

Ranked order	Accession no. Height	Width	Length
45.	84	45	28
46.	86	85	12
47.	60	72	34
48.	22	39	24
49.	45	86	56
50.	43	21	33
51.	5	5	57
52.	26	75	26
53.	7	74	21
54	39	28	39
55.	74	13	65
56.	33	61	19
57.	82	70	60
58.	49	7	85
59.	23	33	42
60.	72	56	23
61.	56	6	72
62.	57	23	5
63.	85	57	90
64.	70	59	61
65.	62	4	88
66.	71	54	3
67.	69	2	4

Ranked order	Accession no. Height	Width	Length
68.	6	60	69
69.	28	53	82
70.	44	69	13
71.	48	62	6
72.	88	88	4
73.	54	49	58
74.	52	44	48
75.	90	48	49
76.	53	90	44
77.	65	52	7
78.	47	65	46
79.	68	46	52
80.	46	47	59
81.	58	51	2
82.	61	58	53
83.	59	82	63
84.	51	68	51
85.	63	55	66
86.	55	64	55
87.	50	66	50
88.	73	50	64
89.	64	63	68
90.	66	73	73

Table 3 Detailed data of Biomass accession in the field on different growth characteristics

Accession no.	Height (cm)	Width (cm)	Length (cm)	Canopy (m3)
1.	66.83	56.67	47.17	0.18
2.	56.00	45.67	30.17	0.08
3.	58.83	51.67	37.67	0.12
4.	58.17	46.00	37.33	0.10
5.	54.50	49.17	38.83	0.11
6.	51.25	47.17	35.50	0.09
7.	54.33	47.50	34.00	0.09
8.	58.33	57.17	45.67	0.15
9.	66.03	62.17	47.00	0.20
10.	74.17	67.17	52.83	0.26
11.	68.50	67.00	52.67	0.25
12.	56.17	53.33	42.33	0.13
13.	56.17	48.00	36.67	0.10
14.	57.83	59.83	45.67	0.16
15.	65.50	63.17	56.17	0.23
16.	67.67	68.00	52.17	0.24
17.	63.00	63.00	47.83	0.19
18.	64.33	59.83	50.00	0.19
19.	57.67	56.83	39.17	1.30
20.	67.83	68.00	58.00	0.23
21.	56.00	49.17	39.67	0.11
22.	55.17	56.17	42.50	0.13

Accession no.	Height (cm)	Width (cm)	Length (cm)	Canopy (m3)
23.	53.00	47.00	39.17	0.10
24.	59.33	54.67	42.17	0.14
25.	59.33	61.17	52.67	0.19
26.	54.33	55.50	40.00	0.12
27.	64.17	58.33	54.50	0.20
28.	51.00	48.33	42.50	0.11
29.	67.00	67.83	47.00	0.21
30.	74.00	68.83	57.50	0.30
31.	68.33	66.50	52.67	0.24
32.	66.00	61.33	47.33	0.19
33.	53.50	47.50	40.50	0.11
34.	56.00	53.00	42.33	0.13
35.	66.50	65.17	54.67	0.24
36.	60.33	56.00	42.83	0.14
37.	59.67	55.83	49.67	0.17
38.	63.17	58.17	44.33	0.16
39.	54.17	50.17	39.33	0.11
40.	59.83	59.83	42.83	0.16
41.	66.33	59.83	45.33	0.18
42.	61.00	54.67	39.17	0.13
43.	55.17	51.67	45.67	0.13
44.	50.33	43.50	34.00	0.08
45.	55.17	51.50	44.17	0.13
46.	47.33	41.83	33.83	0.07

Accession no.	Height (cm)	Width (cm)	Length (cm)	Canopy (m3)
47.	47.67	41.83	49.17	0.10
48.	50.00	43.17	35.00	0.08
49.	53.17	43.83	34.83	0.08
50.	39.83	33.83	28.83	0.04
51.	45.17	40.17	29.67	0.05
52.	49.33	42.33	32.67	0.07
53.	48.67	45.67	29.83	0.07
54	49.50	46.00	35.50	0.08
55.	43.00	36.67	29.00	0.05
56.	52.83	47.17	42.00	0.11
57.	52.50	46.67	40.33	0.10
58.	47.17	40.17	35.33	0.07
59	46.00	46.17	31.50	0.07
60.	55.50	45.67	39.17	0.10
61.	47.17	47.83	38.33	0.09
62.	51.83	45.50	45.33	0.11
63.	43.67	32.33	29.83	0.04
64.	49.50	35.50	23.17	0.04
65.	48.33	42.33	39.17	0.08
66.	35.42	34.33	29.58	0.04
67.	58.67	59.33	49.33	0.17
68.	47.50	37.50	28.17	0.05
69.	51.50	45.50	36.83	0.09
70.	51.83	47.83	43.67	0.11

Accession no.	Height (cm)	Width (cm)	Length (cm)	Canopy (m3)
71.	51.67	53.83	46.17	0.13
72.	53.00	51.00	39.00	0.11
73.	39.83	30.00	26.00	0.03
74.	53.67	48.33	44.17	0.11
75.	57.00	48.50	44.33	0.12
76.	67.50	61.50	58.83	0.25
77.	76.04	69.83	64.17	0.34
78.	68.00	61.50	57.50	0.26
79.	58.00	57.00	43.83	0.15
80.	57.50	55.67	45.17	0.15
81.	71.00	68.83	64.50	0.32
82.	53.50	39.83	36.83	0.08
83.	60.17	56.83	53.00	0.18
84.	56.00	53.67	47.17	0.14
85.	52.00	51.00	39.17	0.10
86.	55.83	49.67	43.83	0.12
87.	62.00	59.17	52.17	0.19
88.	49.50	43.83	37.83	0.08
89.	62.17	51.50	49.00	0.16
90.	48.83	42.83	38.67	0.08

Table 4 Detailed data of Biomass accessions in the container with statistical analysis (Duncan's Multiple Range Test, $\alpha = 0.01$)

Ranked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession No.	Lenght (cm)
1.	49	151.25 A	49	77.71 A	49	87.33 A
2.	74	140.63 AB	87	77.67 A	46	84.58 AB
3.	60	139.63 AB	47	74.58 AB	40	84.46 ABC
4.	46	138.63 AB	88	72.96 ABC	47	83.63 ABCD
5.	50	136.54 ABC	90	72.83 ABC	14	80.96 ABCDE
6.	43	136.13 ABC	43	71.13 ABCD	60	80.17 ABCDE
7.	47	136.00 ABCD	50	70.38 ABCDE	52	78.63 ABCDE
8.	58	135.96 ABCD	79	70.35 ABCDE	50	77.71 ABCDE
9.	79	135.72 ABCD	74	70.04 ABCDE	74	77.54 ABCDE
10.	35	135.58 ABCD	58	69.25 ABCDE	58	77.38 ABCDE
11.	61	135.17 ABCD	51	69.00 ABCDE	84	76.83 ABCDE
12.	86	135.17 ABCD	60	68.38 ABCDE	72	76.38 ABCDE
13.	40	134.67 ABCD	18	67.83 ABCDE	33	76.25 ABCDE
14.	8	134.29 ABCD	66	67.50 ABCDE	37	76.08 ABCDE
15.	90	134.21 ABCD	35	67.21 ABCDE	79	75.92 ABCDE
16.	57	133.92 ABCD	33	67.08 ABCDE	57	75.83 ABCDE
17.	37	133.63 ABCD	14	65.88 ABCDE	51	75.79 ABCDE
18.	44	133.38 ABCD	78	65.74 ABCDE	18	75.54 ABCDE
19.	51	133.33 ABCD	77	65.67 ABCDE	31	75.29 ABCDE
20	72	133.04 ABCD	84	65.55 ABCDE	59	74.83 ABCDE

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Panked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession No.	Lenght (cm)
21.	12	132.96 ABCD	70	65.00 ABCDE	45	74.71 ABCDE
22.	52	132.92 ABCD	57	64.88 ABCDE	77	74.47 ABCDE
23.	75	132.92 ABCD	72	64.88 ABCDE	44	74.46 ABCDE
24.	54	132.29 ABCD	80	64.86 ABCDE	35	74.29 ABCDE
25.	31	132.00 ABCD	52	64.75 ABCDE	87	74.21 ABCDE
26.	36	131.50 ABCD	46	64.71 ABCDE	32	74.00 ABCDE
27.	5	131.33 ABCD	63	64.64 ABCDE	26	73.75 ABCDE
28.	70	131.29 ABCD	59	64.54 ABCDE	61	73.63 ABCDE
29.	62	130.96 ABCD	37	64.50 ABCDE	73	72.79 ABCDEF
30.	32	130.79 ABCDE	32	64.25 ABCDE	43	72.75 ABCDEF
31.	63	130.40 ABCDE	6	64.13 ABCDE	36	72.71 ABCDEF
32.	73	130.38 ABCDE	31	64.13 ABCDE	68	72.33 ABCDEF
33.	45	129.92 ABCDE	86	63.83 ABCDE	28	72.25 ABCDEF
34.	89	129.67 ABCDE	83	63.75 ABCDE	24	72.17 ABCDEF
35.	69	129.54 ABCDE	73	63.29 ABCDE	70	72.13 ABCEDF
36.	33	129.38 ABCDE	40	62.88 ABCDE	66	72.00 ABCDEF
37.	88	129.38 ABCDE	61	61.88 ABCDE	38	71.71 ABCDEF
38.	85	128.46 ABCDE	75	61.71 ABCDE	76	71.38 ABCDEF
39.	30	128.38 ABCDE	44	61.67 ABCDE	11	71.00 ABCDEF
40.	4	128.29 ABCDE	65	61.33 ABCDE	20	70.83 ABCDEF
41.	14	128.08 ABCDE	5	61.33 ABCDE	62	70.83 ABCDEF
42.	26	127.38 ABCDE	41	61.29 ABCDE	78	70.78 ABCDEF
43.	66	126.71 ABCDE	62	61.21 ABCDE	63	70.56 ABCDEF
44.	24	126.65 ABCDE	85	60.83 ABCDE	12	70.21 ABCDEF

Ranked order	Accession no.	Height (cm)	Accession no.	width (cm)	Accession No.	Lenght (cm)
45.	18	126.42 ABCDE	69	60.75 ABCDE	69	69.83 ABCDEF
46.	84	126.04 ABCDE	71	60.22 ABCDE	65	63.79 ABCDEF
47.	6	125.67 ABCDE	68	60.21 ABCDE	19	69.67 ABCDEF
48.	15	125.67 ABCDE	81	59.42 ABCDE	88	69.58 ABCDEF
49.	59	125.57 ABCDE	89	59.26 ABCDE	5	69.33 ABCDEF
50.	65	125.54 ABCDE	54	59.25 ABCDE	6	69.13 ABCDEF
51.	87	124.92 ABCDE	26	59.21 ABCDE	1	69.00 ABCDEF
52.	1	124.79 ABCDE	7	59.17 ABCDE	53	68.92 ABCDEF
53.	71	124.78 ABCDE	45	59.17 ABCDE	42	68.25 ABCDEF
54.	25	124.50 ABCDE	56	58.96 ABCDE	90	68.17 ABCDEF
55.	48	124.50 ABCDE	76	58.58 ABCDE	75	67.83 ABCDEF
56.	68	124.46 ABCDE	82	58.58 ABCDE	85	67.79 ABCDEF
57.	20	123.83 ABCDE	48	58.22 ABCDE	71	67.56 ABCDEF
58.	67	123.63 ABCDE	42	58.17 ABCDE	86	67.54 ABCDEF
59.	21	123.56 ABCDE	53	58.13 ABCDE	4	67.29 ABCDEF
60.	11	123.54 ABCDE	1	57.75 ABCDE	25	66.96 ABCDEF
61.	76	122.92 ABCDE	36	57.13 ABCDE	41	66.71 ABCDEF
62.	64	122.83 ABCDE	20	56.92 ABCDE	15	66.67 ABCDEF
63.	78	122.31 ABCDE	16	56.67 ABCDE	21	66.51 ABCDEF
64.	41	122.29 ABCDE	11	56.63 ABCDE	8	66.21 ABCDEF
65.	42	122.06 ABCDE	25	56.29 ABCDE	56	65.96 ABCDEF
66.	77	121.75 ABCDE	67	56.08 ABCDE	55	65.63 ABCDEF
67.	56	120.88 ABCDE	28	56.04 ABCDE	16	65.38 ABCDEF
68.	10	120.38 ABCDE	15	55.83 ABCDE	30	65.17 ABCDEF

Ranked order	Accession no.	Height (cm)		Accession no.	width (cm)		Accession No.	Lenght (cm)	
69.	29	120.38	ABCDE	17	55.63	ABCDE	10	64.92	ABCDEF
70.	81	119.97	ABCDE	21	55.43	ABCDE	48	64.90	ABCDEF
71.	7	119.88	ABCDE	8	55.42	ABCDE	29	64.42	ABCDEF
72	16	118.92	ABCDE	64	55.38	ABCDE	7	64.17	ABCDEF
73.	22	117.08	BCDE	4	55.33	ABCDE	2	63.75	ABCDEF
74.	19	116.04	BCDE	24	55.29	ABCDE	39	63.71	ABCDEF
75.	55	115.54	BCDE	38	55.13	ABCDE	80	63.13	ABCDEF
76.	23	115.17	BCDE	19	55.08	ABCDE	34	63.13	ABCDEF
77.	39	115.08	BCDE	30	54.92	ABCDE	3	62.88	ABCDEF
78.	53	115.08	BCDE	29	54.25	ABCDE	9	62.83	ABCDEF
79.	83	115.00	BCDE	12	54.13	ABCDE	89	62.54	ABCDEF
80	34	114.92	BCDE	55	54.00	ABCDE	83	62.25	ABCDEF
81.	38	144.75	BCDE	9	53.79	ABCDE	67	62.13	ABCDEF
82	28	114.54	BCDE	39	50.92	ABCDE	81	62.00	ABCDEF
83.	9	114.46	BCDE	34	50.88	ABCDE	17	60.00	BCDEF
84.	80	112.45	BCDE	10	50.83	ABCDE	64	59.88	BCDEF
85.	17	112.25	BCDE	3	49.67	BCDE	23	59.29	BCDEF
86.	3	110.17	BCDE	22	47.29	BCDE	22	57.83	CDEF
87.	2	108.58	BCDE	23	46.88	CDE	54	57.63	DEF
88.	13	105.25	CDE	2	46.17	CDE	13	54.92	EF
89.	82	103.17	DE	13	44.96	DE	82	54.25	EF
90	27	98.38	E	27	43.21	E	27	47.08	F

Table 5 Detailed data of Biomass accessions in the container on ranked order

Ranked order	Accession		
	Height	width	Lenght
1.	49	49	49
2.	74	87	46
3.	60	47	40
4.	46	88	47
5.	50	90	14
6.	43	43	60
7.	47	50	52
8.	58	79	50
9.	79	74	74
10.	35	58	58
11.	61	51	84
12.	86	60	72
13.	40	18	33
14.	8	66	37
15.	90	35	79
16.	57	33	57
17.	37	14	51
18.	44	78	18
19.	51	77	31
20.	72	84	59
21.	12	70	45

Ranked order	Accession		
	Height	width	Lenght
22.	52	57	77
23.	75	72	44
24.	54	80	35
25.	31	52	87
26.	36	46	32
27.	5	63	26
28.	70	59	61
29.	62	37	73
30.	32	32	43
31.	63	6	36
32.	73	31	68
33.	45	86	28
34.	89	83	24
35.	69	73	70
36.	33	40	66
37.	88	61	38
38.	85	75	76
39.	30	44	11
40.	4	65	20
41.	14	5	62
42.	26	41	78
43.	66	62	63
44.	24	85	12

Ranked order	Accession		
	Height	width	Lenght
45.	18	69	69
46.	84	71	65
47.	6	68	19
48.	15	81	88
49.	59	89	5
50.	65	54	6
51.	87	26	1
52.	1	7	53
53.	71	45	42
54.	25	56	90
55.	48	76	75
56.	68	82	65
57.	20	48	71
58.	67	42	86
59.	21	53	4
60.	11	1	25
61.	76	36	41
62.	64	20	15
63.	78	16	21
64.	41	11	8
65.	42	25	56
66.	77	67	55
67.	56	28	16

Ranked order	Accession		
	Height	width	Lenght
68.	10	15	30
69.	29	17	10
70.	81	21	48
71.	7	8	29
72.	16	64	7
73.	22	4	2
74.	19	24	39
75.	55	38	80
76.	23	19	34
77.	39	30	3
78.	53	29	9
79.	83	12	89
80	34	55	83
81.	38	9	67
82	28	39	81
83.	9	34	17
84.	80	10	64
85.	17	3	23
86.	3	22	22
87.	2	23	54
88.	13	2	13
89.	62	13	82
90.	27	27	27

Table 6 Detailed data of Biomass accessions in the container on different growth characteristics

Accession no.	Heigth (cm)	Width (cm)	Length (cm)	Canopy (m^3)
1.	124.79	57.75	69.00	0.50
2.	108.58	46.17	63.75	0.27
3.	110.17	49.67	62.88	0.25
4.	128.29	55.33	67.29	0.47
5.	131.33	61.33	69.33	0.56
6.	125.67	64.13	69.13	0.49
7.	119.88	59.17	64.17	0.45
8.	134.29	55.42	66 21	0.49
9.	114.46	53.79	62.83	0.50
10.	120.38	50.83	64.92	0.40
11.	123.54	56.63	71.00	0.50
12.	132.96	54.13	70.21	0.50
13.	105.25	44.96	54.92	0.26
14.	128.08	65.88	80.96	0.68
15.	125.67	55.83	66.67	0.45
16.	118.92	56.67	65.38	0.44
17.	112.25	55.63	60.00	0.38
18.	126.42	67.83	75.54	0.65
19.	116.04	55.08	69.67	0.45
20	123.83	56.92	70.83	0.50
21	123.56	55.43	66.51	0.46
22.	117.08	47.29	57.83	0.32

Accession no.	Heigth (cm)	Width (cm)	Length (cm)	Canopy (m^3)
23.	115.17	46.88	59.29	0.32
24.	126.65	55.29	72.17	0.46
25.	124.50	56.29	66.96	0.55
26.	127.38	59.21	73.75	0.56
27.	98.38	43.21	47.08	0.38
28.	114.54	56.04	72.25	0.46
29.	120.38	54.25	64.42	0.42
30.	128.38	54.92	65.17	0.46
31.	132.00	64.13	75.29	0.63
32.	130.79	64.25	74.00	0.62
33.	129.38	67.08	76.25	0.66
34.	114.92	50.88	63.13	0.37
35.	135.58	67.21	74.29	0.67
36.	131.50	57.13	72.71	0.55
37.	133.63	64.50	76.08	0.66
38.	114.75	55.13	71.71	0.46
39.	115.08	50.92	63.71	0.38
40.	134.67	62.88	84.46	0.71
41.	122.29	61.29	66.71	0.50
42.	122.08	58.17	68.25	0.48
43.	136.13	71.13	72.75	0.71
44.	133.38	61.67	74.46	0.61
45.	129.92	59.17	74.71	0.58
46.	138.63	64.71	84.58	0.77

Accession no.	Heigth (cm)	Width (cm)	Length (cm)	Canopy (m^3)
47.	136.00	74.58	83.63	0.86
48.	124.50	58.22	64.90	0.47
49.	151.25	77.71	87.33	1.03
50.	136.54	70.38	77.71	0.71
51.	133.33	69.00	75.79	0.70
52.	132.92	64.75	78.63	0.68
53.	115.08	58.13	68.92	0.46
54.	132.29	59.25	57.63	0.45
55.	115.54	54.00	65.63	0.41
56.	120.88	58.96	65.96	0.47
57.	133.92	64.88	75.83	0.66
58.	135.96	69.25	77.38	0.72
59.	125.57	64.54	74.83	0.61
60.	139.63	68.38	80.17	0.76
61.	135.17	61.88	73.63	0.62
62.	130.96	61.21	70.83	0.57
63.	130.40	64.64	70.56	0.60
64.	122.83	55.38	59.88	0.41
65.	125.54	61.33	69.79	0.54
66.	126.71	67.50	72.00	0.62
67.	123.63	56.08	62.13	0.43
68.	124.46	60.21	72.33	0.54
69.	129.54	60.75	69.83	0.56
70.	131.29	65.00	72.13	0.61

Accession no.	Heigth (cm)	Width (cm)	Length (cm)	Canopy (m^3)
71.	124.78	60.22	67.56	0.51
72.	133.04	64.88	76.38	0.66
73.	130.38	63.29	72.79	0.60
74.	140.63	70.04	77.54	0.77
75.	132.92	61.71	67.83	0.56
76.	122.92	58.58	71.38	0.52
77.	121.75	65.67	74.47	0.60
78.	122.31	65.74	70.78	0.57
79.	135.72	70.35	75.92	0.72
80.	112.45	64.86	63.13	0.46
81.	119.97	59.42	62.00	0.44
82.	103.17	58.58	54.25	0.33
83.	115.00	63.75	62.25	0.46
84	126.04	65.55	76.83	0.64
85.	128.46	60.83	67.79	0.53
86.	135.17	63.83	67.54	0.59
87.	124.92	77.67	74.21	0.72
88.	129.38	72.96	69.58	0.66
89.	129.67	59.26	62.54	0.48
90.	134.21	72.83	68.17	0.67

Table 7 canopy and diameter of rootstock in relation to number of stomata

Series No.	Stomatal Class	Canopy (m^3)	Diameter (cm)	number of Rootstock
1.	3.51 - 4.00	0.2438	0.940	1
2.	4.01 - 4.50	0.2338	0.940	1
3.	4.51 - 5.00	0.1673	0.933	6
4.	5.01 - 5.50	0.1151	0.793	51
5.	5.51 - 6.00	0.1146	0.730	127
6.	6.01 - 6.50	0.1152	0.782	107
7.	6.51 - 7.00	0.1381	0.776	81
8.	7.01 - 7.50	0.1237	0.787	39
9.	7.51 - 8.00	0.1458	0.772	18
10.	8.01 - 8.50	0.1909	0.844	8
11.	8.51 - 9.00	0.1722	0.873	3
12.	9.01 - 9.50	0.3366	1.120	2
13.	9.51 - 10.00	0.3600	1.000	1

Table 8 Detailed data of Dwarf No.1 Plant

Node No. / Terminal shoot No.	1	2	3	4	5	6	7	8	9	10	Total	Average
1	0.5	1.0	1.0	1.5	1.9	2.0	1.7	1.5	1.3	-	12.4	1.37
2	1.0	0.5	0.5	0.7	1.0	1.5	1.7	2.0	1.4	-	10.3	1.14
3	1.6	1.8	1.5	1.2	1.0	0.7	2.0	2.5	1.6	2.5	16.4	1.64
4	0.6	1.0	2.0	1.7	2.2	1.2	1.2	-	-	-	9.9	1.41
5	0.5	0.7	0.5	2.0	1.8	1.8	1.4	-	-	-	8.2	1.17
6	1.0	1.0	2.0	2.4	2.7	2.0	2.0	-	-	-	13.1	1.87
7	1.3	1.8	1.7	2.2	1.4	1.7	2.0	2.2	2.0	2.0	18.3	1.83
8	1.0	1.7	2.0	2.2	2.0	1.0	0.5	-	-	-	10.4	1.48
9	0.6	0.3	1.7	2.0	1.2	0.8	0.3	0.3	-	-	7.2	0.90
10	1.1	2.0	2.0	2.4	3.0	-	-	-	-	-	10.5	2.10
Total	8.2	11.8	14.9	18.3	18.2	12.7	12.8	8.5	6.3	4.5	116.7	14.91
											Average	1.491

Table 9 Detailed data of Dwarf No.2 Plant.

Node No. / Terminal shoot No.	1	2	3	4	5	6	7	8	9	10	Total	Average
1.	0.9	0.9	1.0	1.3	2.0	2.2	2.7	2.5	2.4	2.5	18.4	1.84
2.	1.2	2.0	1.8	2.0	2.0	2.3	2.4	2.6	1.9	1.9	20.1	2.01
3.	1.1	1.4	2.6	2.7	2.0	2.4	2.4	2.0	2.0	1.0	19.6	1.96
4.	0.5	0.8	1.2	1.5	1.9	2.0	2.0	2.4	2.3	2.5	17.1	1.71
5.	1.0	1.0	1.4	1.2	2.0	1.7	2.0	2.6	2.3	2.0	17.2	1.72
6.	0.6	0.6	1.0	1.0	1.6	1.7	1.9	2.0	2.4	2.0	14.8	1.48
7.	1.0	1.0	1.2	1.7	1.7	2.2	2.6	2.8	2.8	2.6	19.6	1.96
8.	0.5	0.4	1.8	1.6	2.0	2.4	2.6	2.5	3.0	2.6	19.4	1.94
9.	1.8	1.6	1.1	0.6	0.8	1.8	2.0	2.3	2.5	2.8	17.3	1.73
10.	1.0	1.2	1.7	1.8	1.5	2.2	3.0	2.6	2.5	2.3	19.8	1.98
Total	**9.6**	**10.6**	**14.8**	**15.4**	**17.5**	**20.9**	**23.6**	**24.3**	**24.1**	**22.2**	**183.3**	**18.33**
											Average	1.833

Table 10 Detailed data of No. 87-2-17-021 Plant.

Node No. / Terminal shoot No.	1	2	3	4	5	6	7	8	9	10	Total	Average
1.	2.0	2.0	3.0	3.2	3.2	3.0	2.0	2.0	-	-	20.4	2.55
2.	1.0	2.3	2.3	1.8	1.8	3.0	1.9	1.3	1.0	1.2	17.6	1.76
3.	1.5	2.5	2.0	2.0	1.8	2.3	1.6	2.0	1.5	1.2	18.4	1.84
4.	2.0	2.5	3.0	2.8	2.5	2.0	-	-	-	-	14.8	1.48
5.	1.0	1.0	1.4	2.3	3.2	3.7	4.0	3.5	2.0	0.8	22.8	2.29
6.	0.7	2.0	2.0	3.0	1.3	1.3	0.8	0.8	-	-	11.9	1.48
7.	1.4	1.0	1.0	0.6	0.8	2.3	2.0	3.3	2.3	2.3	17.0	1.70
8.	1.5	1.8	1.3	0.8	0.3	0.3	0.3	0.7	0.5	1.5	9.0	0.90
9.	1.5	1.5	1.0	0.7	1.5	2.0	2.3	1.8	1.7	0.5	14.5	1.45
10.	2.0	1.8	1.3	1.0	1.0	0.8	1.2	1.9	2.0	3.0	16.0	1.60
Total	14.6	18.4	18.3	18.2	17.4	20.7	16.1	16.3	11.0	10.5	162.4	17.05
							Average					1.705

Table 11 Culture for Rhizobium study

I. Phenol red broth base (PRBB) with carbohydrate.

Constituents

Beef extract	1.0	g
Proteose peptone No.3	10.0	g
$NaCl$	5.0	g
Phenol red	0.018	g
Carbohydrate	5.0	g
Distilled water	1000.0	ml

pH 7.4

Carbohydrate : glucose, sucrose, lactose or manitol.

II. Mannitol Medium.

Constituents

Yeast extract	30.0	g
$MgSO_4 7H_2O$	0.2	g
K_2HPO_4	0.5	g
Mannitol	10.0	g
Distilled water	1000.0	ml

pH 6.8

III. Simmon's citrate agar

Constituents

$MgSO_4 . 5 H_2O$	0.2	g
$NH_4H_2PO_4$	1.0	g
K_2HPO_4	1.0	g
Sodium citrate (dehydrate)	2.0	g
NaCL	5.0	g
Agar	15.0	g
Bromthymol blue	0.08	g
Distilled water	1000.0	ml

pH 6.9

Fig 1. A twin sweet-sour tamarind tree grown from different seeds in the same hill.

Fig. 2 A twin sweet-sour tamarind tree with owner (enlarged)

Fig. 3 Enlargement of the tamarind trunk indicates the bark pattern, left one is sweet type and right one is sour type.

Fig 4. A rare and valuable sour tamarind accession gives an amber pulp.

Fig. 5 A huge sour tamarind tree of sixty-six year old produces the highest pod yield.

Fig. 6 A dwarf tamarind tree
(mango tree in background)
of thirty year old with
four metre height.

Fig. 7 The operation on Tamarind Accession Data collection and propagation by inarching.