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Evaluation of selected genotypes from 1981 *Hevea* germplasm using morphological and physiological parameters in Sri Lanka

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Abstract

Most Hevea breeders believe they have exploited the maximum genetic variability of Wickham's original introduction of Hevea brasiliensis (Willd.ex A. Juss.) Mull.Arg. Therefore, to broaden the genetic base of the major producers of natural rubber, it became necessary to undertake an expedition to the Amazon basin to obtain materials for the 'gene pool' in these populations. This expedition is called "Germplasm 81". Sri Lanka received around 10,000 accessions from this expedition and they were planted in Neuchatel Estate of Kalutara District. But in Sri Lanka a proper selection evaluation of genotypes from 1981 Hevea germplasm collection has not been conducted. Therefore, this study was conducted to select superior genotypes from 1981 germplasm collection using morphological and physiological parameters. Twenty-five accessions were selected out of around 2000 accessions by evaluating their girth, bark thickness, canopy architecture and latex flow as preliminary selection criteria. These 25 accessions were multiplied and planted in a completely randomized blocked design with three replicates and each replicate contained five plants from each 25 accessions and clone RRIC 121 and RRISL 203 were used as control clones. Then, their girth, leaf area, chlorophyll content, leaf colour, tree height and inter whorl length were recorded. All parametric data were analyzed using one - way ANOVA and Duncan's multiple range test to study the differences among accessions. According to results, accessions MT 11-76 I, MT 11-76 II, MT 10-146 and MT 11-13 were also shown to have better growth performances than other accessions and control clones. Also, their disease incidences were at a very low level. In addition to these four selections, accession MT 7-36, AC 6-13, MT 11-88 and RO 2-4 also showed good performances from observed parameters but they could not meet adequate performances as MT 11-76 I, MT 11-76 II, MT 10-146 and MT 11-13. However, it is important to take long term observations and yield parameters for further verifications of these accessions before adding them into the Breeding pool.

Key words: Breeding, Hevea, Germplasm, Accession

INTRODUCTION

Rubber [Hevea brasiliensis (willd.ex Adr. de Juss.) Muell.Arg.], whose center of diversity is the Amazon basin, is the prime source of natural rubber. It was first introduced to the world from its native, tropical rain forests of South America, when 70,000 seeds brought by Sir Henry Wickham were germinated at the Kew gardens, England. The first commercial plantation in Sri Lanka was started subsequently in 1883 and rubber breeding in Sri Lanka is largely based on a small population of about 1919 seedlings introduced in 1876 from Wickham collection. This Wickham genetic base has been utilized extensively for Hevea genetic improvement programmes (Withanage, 2015). Therefore, Most Hevea breeders believe that they have exploited the maximum genetic variability of Wickham's original introduction and have provided original materials for plant breeding program and crop improvement.

Therefore, in the 1970s, the need for new Hevea genetics stemmed from the realization that there was a gradual erosion of the genetic diversity of rubber clones on many natural rubber plantations. This erosion occurred because most of the clones in cultivation were derived from the few surviving seeds collected in 1876 by Sir Henry Wickham. Hence, it was needed to expand the genetic diversity of the major natural rubber producers. Therefore, the necessity arose for another expedition to the Amazon basin to collect materials for the current "gene pool" and this expedition is called "Genetic Material 81". (Onokpise, 2004). Here, wild Hevea germplasm has been imported to selected countries, Sri Lanka has already received about 10,000 genotypes from Malaysia and Ivory Coast. (Withanage, 2015). Except for a few evaluations in the past, direct large-scale selection of superior genotypes has not been performed from the 1981 Hevea genotype. Hence, this study was carried out to analyze selected accessions from 1981 Hevea germplasm to develop a genetically diverse clone with suitable characteristics using morphological and physiological parameters to evaluate and characterize the appropriate accessions to be used for an additional hybridization program or to be developed as a clone. Morphological and physiological descriptors have been used successfully in germplasm characterization and other genetic diversity studies in various crops worldwide (Perera and Fernando, 2000).

MATERIALS AND METHODS

This experiment was conducted at the 1981 germplasm nursery in Neuchatel estate (6.620 N and 80.020 E) at Galpatha, Horana in Kalutara District, belongings to Genetics and Plant Breeding Department of Rubber Research Institute of Sri Lanka. The

experimental site is located in the low country wet zone (WL2) at an elevation of 9 m above the mean sea level. It has red yellow podzolic soil and annual rainfall for the region is about 1900 mm. The total extent of this ex-situ collection is 13 ha and four plants from each genotype planted an space having dimensions of (1m x 1m).

Preliminary Selection Around 8000 accessions were established in 1981 Hevea germplasm nursery at Neuchatel estate and the expedition is now about 35 years old. Out of all these accessions, around 2000 accessions were evaluated and highly performing 25 accessions were selected based on their girth, bark thickness, latex flow (g/t/t) and canopy architecture as preliminary observations.

- Girth : - The girth measurements were made in plants at 120cm above bud union using a measuring tape
- Bark thickness : - Bark thickness was measured at 120cm above bud union using a bark gauge
- Floral canopy : - According to canopy density volume different ratings were given to each accession through the visual observation.

Table 1. *Ratings allotted for canopy density volume*

Canopy Density Volume	Rating
< 25 %	1
25 % to 50 %	2
50 % to 75 %	3
> 75 %	4

- **Latex flow**: - Latex flow of each genotype was measured by micro tapping for 3 months.

These selections were multiplied by bud grafting and the new plants were planted in completely randomized block design with three replicates and each replicate contain five plants from each 25 accessions. Also, RRIC 121 and RRISL 203 were used as control clones from recommended clones.

After one year of planting, the measurements were taken and as morphological and physiological measurements their girth, leaf area, chlorophyll content, leaf color, tree height and inter whorl length were recorded.

Girth

Girth was measured at 60cm height from the bud union on each plant using a Vernier caliper.

Leaf Area
After reaching full leaf expansion, measurements were made on newly emerging leaf whorl of each plant of each accession and control clones using a portable leaf area meter (LI-3000C, Ll-Cor, Nebraska, U.S.A.).

Chlorophyll Content
To minimize the diurnal influences chlorophyll content was measured between 9:00 am to 12:00 noon with a temperature range between 30°C to 34°C. Measurements were taken at the middle of the leaf surface (apart from the main vein) in three different positions, (on the upper, middle and lower parts) of the plant. Measurements were made on each plant of each accession and control clones using a chlorophyll meter (SPAD-502).

Leaf Colour
The colour of leaf blade generally appears in a range from dark green, green, light green, yellowish green and bluish green. The colour of the plants can be determined by using a slandered colour charts for plant tissues (as directed by the IPGRI). Therefore, Munsell colour chart for plant tissues was used to determine the intensity of the colour of leaves of each accession and control clones. Also, the colour codes and ratings are allotted to them according to colour intensity.

Table 2. *Colour codes of the Munsell colour chart and the ratings allotted to them for colour descriptors*

Colour code	Rating
7.5GY 5/6	1
7.5GY 5/4	2
7.5GY 5/2	3
7.5GY 4/6	4
7.5GY 4/4	5
7.5GY 4/2	6
5GY 5/4	7
5GY 4/4	8
5GY 3/4	9
5GY 3/2	10

Tree height
Total height was measured as the distance along the axis of the tree stem between the ground and the tip of the tree using a measuring tape.

Inter whorl length
The distance between the third and new leaf whorl along the axis was recorded using a measuring tape.

STATISTICAL ANALYSIS

Parametric data analysis has done for the measurements of girth, leaf area, chlorophyll content leaf colour, tree height and inter whorl length of 25 accessions and two control clones in all three replicates. After calculating their mean values for each character, the significant differences of the means were analyzed using one-way ANOVA. When significant differences were detected, multiple comparison procedures (Duncan's Multiple Range Test) were performed to study the differences among the means.

RESULTS AND DISCUSSION

Preliminary selection

In preliminary selection, girth, bark thickness, floral canopy and latex flow (g/t/t) were measured in around 2000 accessions (four plants from one accession) from 1981 germplasm nursery. According to mean values for all criteria of each 2000 accessions, the top performing 25 accessions were selected and their mean values under each criterion are given below in Table 3.

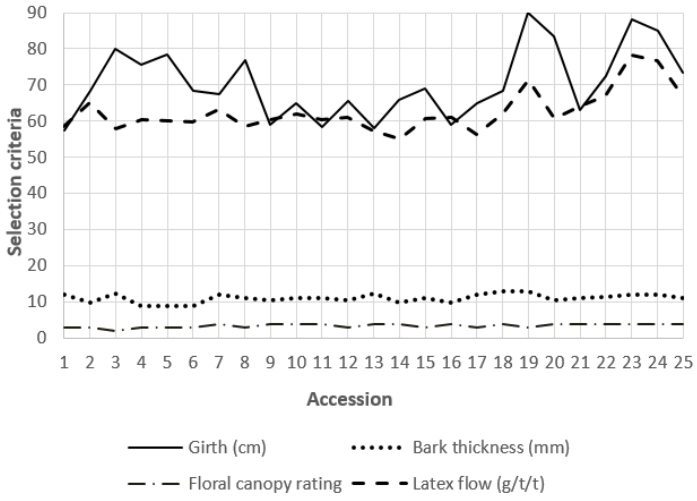
Table 3. *Average values of girth, bark thickness, floral canopy rating and latex flow (g/t/t) of each selected 25 accessions*

Accession	Girth	Bark thickness	Floral canopy rating	Latex flow
1	57.5	12	3	58.5
2	68.5	10	3	65.2
3	80	12.5	2	58
4	75.5	9	3	60.4
5	78.5	9	3	60.2
6	68.5	9	3	59.7
7	67.5	12	4	63.3
8	77	11	3	58.5
9	59	10.5	4	60.3
10	65	11	4	62
11	58.5	11	4	60.5
12	65.5	10.5	3	61
13	58	12.5	4	57.3
14	66	10	4	55
15	69	11	3	60.7
16	59	10	4	61
17	65	12	3	56.4
18	68.5	13	4	62
19	90	13	3	71.4

Accession	Girth	Bark thickness	Floral canopy rating	Latex flow
20	83.5	10.5	4	60.7
21	63	11	4	64.2
22	72.5	11.5	4	67.1
23	88	12	4	78.3
24	85	12	4	76.7
25	73.5	11	4	66.8

All preliminary selection criteria

Based on the average values of girth, bark thickness, floral canopy rating and latex flow (g/t/t) of each selected 25 accessions from preliminary selection criteria, their variations are shown in Figure 1.



Key	
No.	**Accession**
1	1-4
2	1-44
3	1-53
4	RO 2-4
5	RO 2-32
6	RO 2-96
7	RO 3-298
8	RO 3-300
9	RO 3-467
10	AC 4-58
11	AC 5-153
12	AC 5-163
13	AC 6-13
14	MT 7-23
15	MT 7-36
16	MT 7-61
17	MT 7-187
18	MT 10-100
19	MT 10-146
20	MT 10-158
21	MT 10-161
22	MT 11-13
23	MT 11-76 I
24	MT 11-76 II
25	MT 7-88

Fig. 1. Average values of girth, bark thickness, floral canopy rating and latex flow (g/t/t) of each selected 25 accessions

Evaluation of selected accessions and control clones

Mean values of girth, leaf area, leaf colour, tree height, chlorophyll content and inter-whorl length were calculated for each of the 25 accessions and two control clones in all three replicates. Using those mean values one-way ANOVA was carried out with a multiple comparison procedure (Duncan's Multiple Range Test). The results of the test for each parameter are given below.

Tree height

From the analysis of variance (ANOVA) found that the differences in the means of each accession and control clones were statistically significant at $P \leq 0.05$, indicating that tree height significantly differed among different accessions and control clones as shown in Table 4.

Table 4. *Mean values for tree height of each accession with control clones*

Accession	Mean (cm) & DMRT's Group
MT 10-146	155.09^{a}
MT 11-76 II	152.53^{ab}
MT 11-13	152.2^{abc}
RRIC 121- control clone	148.2^{abcd}
MT 7-36	140.23^{abcd}
MT 7-23	138.51^{abcd}
RO 2-4	135.5^{abcd}
AC 6-13	131.42^{abcd}
RO 2-96	130.67^{abcd}
1-44	125.37^{abcd}
MT 7-187	125.29^{abcd}
1-53	123.08^{abcd}
MT 7-61	118.8^{abcd}
1-4	115.47^{abcd}
MT 11-76 I	114.73^{abcd}
RO 3-467	114.65^{abcd}
RO 2-32	114.16^{abcd}
RRISL 203- control clone	111.07^{abcd}
AC 5-163	109.14^{abcd}
AC 4-58	107.51^{abcd}
MT 10-158	104.17^{bcde}
AC 5-153	102.14^{cde}
MT 10-100	100.25^{de}

Accession	Mean (cm) & DMRT's Group
RO 3-298	98.22^{de}
MT 10-161	96.97^{e}
MT 11-88	93.02^{e}
RO 3-300	90.4^{e}

Note: - (Means denoted by the same letter in the column are not significantly different from each other at P≤0.050)

According to Duncan's Multiple Range Test for tree height, the accession MT 10-146 showed the highest value and it was significantly different from other accessions. The second highest was MT 11-76 II and it was also significantly different from rest of other accessions. However, according to the average linkage cluster analyze, three main clusters were identified at an average distance of 0.9 (Fig. 2).

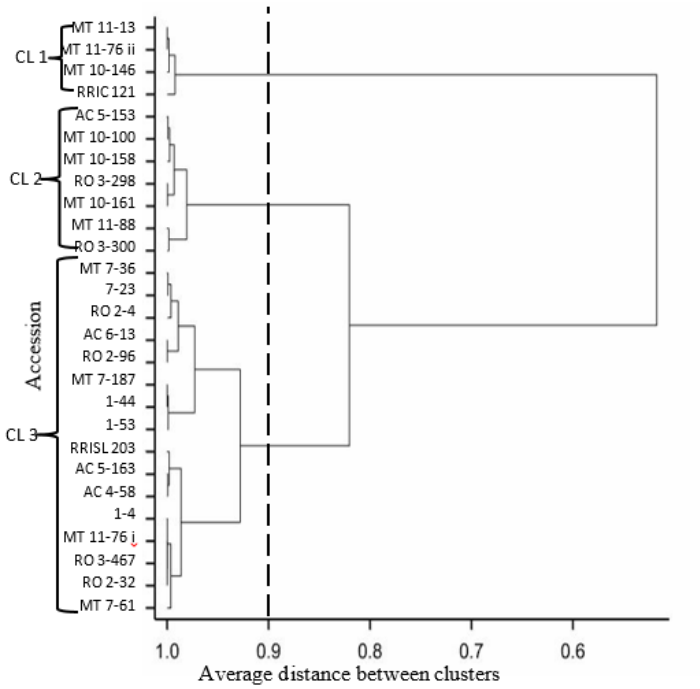


Fig. 2. Dendrogram of 25 accessions and control clones based on average linkage cluster analysis using Tree height values

(CL 1, CL 2 and CL 3 are the different clusters at an average distance of 0.9)

The cluster one consists of three accessions MT 11-13, MT 11-76 II, MT 10-146 and control clone RRIC 121 and it was the cluster which showed the highest tree height. Also, they were clearly separated from other two clusters. The second cluster consists of seven accessions and it was revealed the lowest values. Third cluster consists of remained fifteen accessions and control clone RRISL 203 which showed the second highest tree height values.

Chlorophyll content

Differences in the means of chlorophyll content of each accession and control clones were statistically significant at $P \leq 0.05$, which revealed that chlorophyll content significantly differs among different accessions and control clones as shown in Table 5.

Table 5. *Means for chlorophyll content of each accession with control clones*

Accession	Mean (µg cm^{-2}) & DMRT's Group
MT 11-76 I	56.02^{a}
MT 11-13	55.45^{ab}
MT 10-100	50.19^{abc}
MT 10-146	50.04^{abcd}
AC 4-58	46.88^{abcd}
AC 6-13	46.23^{abcd}
RO 2-96	44.8^{abcd}
AC 5-163	44.16^{abcd}
RRIC 121	44.02^{abcd}
MT 11-76 II	42.43^{abcd}
MT 7-187	42.4^{abcd}
RRISL 203	42.28^{abcd}
AC 5-153	40.55^{abcd}
MT 7-36	39.90^{abcd}
RO 2-32	38.07^{abcd}
MT 10-161	38.02^{abcd}
1-4	37.78^{abcd}
MT 7-23	36.45^{abcd}
MT 7-61	36.41^{abcd}
MT 10-158	36.05^{abcd}
RO 3-467	35.77^{abcd}

1-44	35.64[abcd]
Accession	**Mean (µg cm^{-2}) & DMRT's Group**
RO 3-298	35.08[bcd]
1-53	34.77[cd]
RO 3-300	33.81[cd]
MT 11-88	31.2[cd]
RO 2-4	29.62[d]

Note: - (Means denoted by the same letter in the column are not significantly different from each other at P≤0.050)

Accession MT 11-76 I was shown the highest value and it was significantly different from other accessions and control clones. Other twenty-six accessions were clustered with control clones. Accession RO 2-4 was recorded as the lowest value.

However, according to the average linkage cluster analysis, it has shown three main clusters at an average distance of 0.9 (Figure 3).

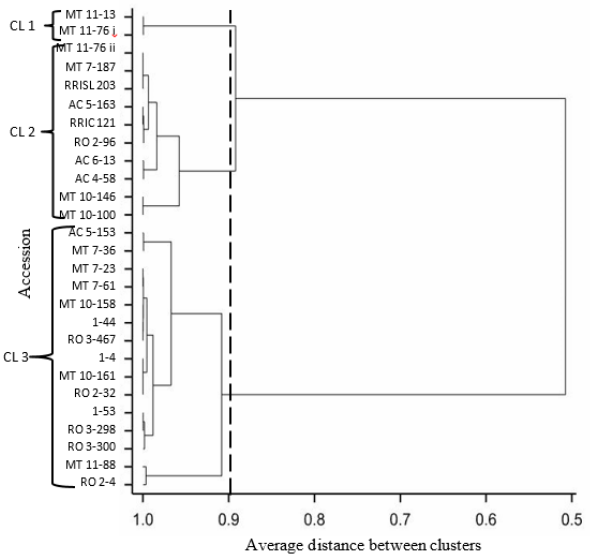


Fig. 3. Dendrogram of 25 accessions and two control clones based on average linkage cluster analysis using chlorophyll content values

(CL 1, CL 2 and CL 3 are the different clusters at an average distance of 0.9)

According to Duncan's Multiple Range Test for chlorophyll content, the first cluster consists of only two accessions, by MT 11-13 and MT 11-76 I. In comparison, they were recorded highest chlorophyll content value. Both control clones were in the second cluster with eight accessions followed the second highest chlorophyll content. The rests of other accessions were clustered into third clustered into the third cluster, which recorded the lowest value.

Girth

It was found that the different means of the girth of these accessions and control clones were statistically significant at $P \leq 0.05$ which indicated that girth is significantly difference among different accessions and control clones as shown in Table 5

Table 5. *Means for girth of each accession with control clones*

Accession	Mean(cm) & DMRT's
MT 11-76 II	18.75^{a}
MT 11-13	18.4^{ab}
1-53	16.4^{abc}
AC 6-13	16.12^{abcd}
RO 2-4	16.11^{abcd}
RRIC 121	16.0^{abcd}
MT 7-36	15.71^{abcd}
MT 10-146	15.55^{abcd}
MT 11-76 I	15.09^{abcde}
1-4	14.73^{abcdef}
RRISL 203	14.49^{bcdefg}
RO 3-467	13.95^{cdefg}
MT 7-187	13.75^{cdefg}
RO 2-32	13.52^{cdefg}
MT 7-23	13.22^{cdefg}
AC 5-163	13.17^{cdefg}
1-44	12.8^{cdefg}
AC 4-58	12.55^{cdefg}
MT 11-88	12.47^{cdefg}
RO 2-96	12.45^{cdefg}
MT 7-61	12.25^{cdefg}
MT 10-158	12.12^{defg}
RO 3-298	11.0^{efg}

AC 5-153	10.94^{efg}
MT 10-161	10.85^{fg}
Accession	**Mean(cm) & DMRT's**
RO 3-300	10.51^{fg}
MT 10-100	10.4^{g}

(Means of the same letters in the column are not significantly different at P≤0.050)

Mean values for the girth of all accessions and control clones were recorded between 10.4 cm and 18.75 cm. The highest girth value was shown in accession MT 11-76 II and it was significantly different from accession RO 3-467, MT 7-187, RO 2-32, MT 7-23, AC 5-163, 1-44, AC 4-58, MT 11-88, RO 2-96, MT 7-61, MT 10-158, RO 3-298, AC 5-153, MT 10-161, RO 3-300, MT 10-100 and control clone RRISL 203. Accession MT 10-100 showed the lowest girth value. However, according to the average linkage cluster analyze, it has shown three main clusters at an average distance of 0.9 (Fig. 4).

Girth has been used extensively as a parameter in the growth and yield estimation of tree crops. Girth and the number of latex vessels in the cortical tissue have together account for yield (Nugawela, 1998). Further, Karunarathna *et al*., (2005) studied the relationship of girth with latex volume and weight of rubber, and they have proved the significant positive correlation between latex yield and girth in tested clones.

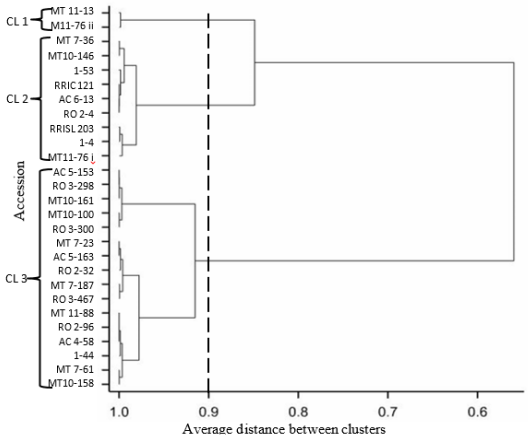


Fig. 4. Dendrogram of 25 accessions and two control clones based on average linkage cluster analysis using girth values

(CL 1, CL 2 and CL 3 are the different clusters at an average distance of 0.9)

The first cluster consists of two accessions as MT 11-13 and MT 11-76 II, which recorded highest girth values. The second cluster followed the next highest girth values, consisting of seven accessions and two control clones. The third cluster consist of rest of other sixteen accessions and have shown the lowest girth values.

Leaf Colour

From the analysis of variance (ANOVA), it was found that the differences in the means of these accessions and control clones were statistically significant at $P \leq 0.05$ which indicated that leaf colour is significantly different among different accessions and control as shown in Table 6.

Table 6. *Means for leaf color of each accession with control clones*

Accession	Mean & DMRT's
MT 11-76 II	10[a]
MT 11-76 I	10[a]
AC 6-13	9[b]
MT 11-88	9[b]
1-4	9[b]
MT 7-23	9[b]
RO 3-300	9[b]
MT 7-36	9[b]
RO 3-467	9[b]
RRIC 121	8[c]
RO 2-4	8[c]
AC 5-153	8[c]
RO 3-298	8[c]
MT 7-187	7[d]
RO 2-32	7[d]
1-44	6[e]
MT 10-161	6[e]
MT 10-100	5[f]
RO 2-96	4[g]
AC 5-163	4[g]
AC 4-58	4[g]
RRISL 203	3[h]
MT 10-158	3[h]
1-53	2[i]

Accession	Mean & DMRT's
MT 10-146	2[i]
MT 7-61	2[i]
MT 11-13	2[i]

Note: - (Means denoted by the same letter in the column are not significantly different from each other at P≤0.050)

According to Duncan's Multiple Range Test for leaf colour in all accessions and control clones, the average ratings were in between 2 to 10. The accession MT 11-76 I and MT 11-76 I recorded higher values and they were significantly different from other twenty-three accessions as well as from two controls clones. Accessions 1-53, MT 10-146, MT 7-61 and MT 11-13 showed the lowest leaf colour ratings.

According to the average linkage cluster analyze, it has shown three main clusters at average distance of 0.9 (Fig.5).

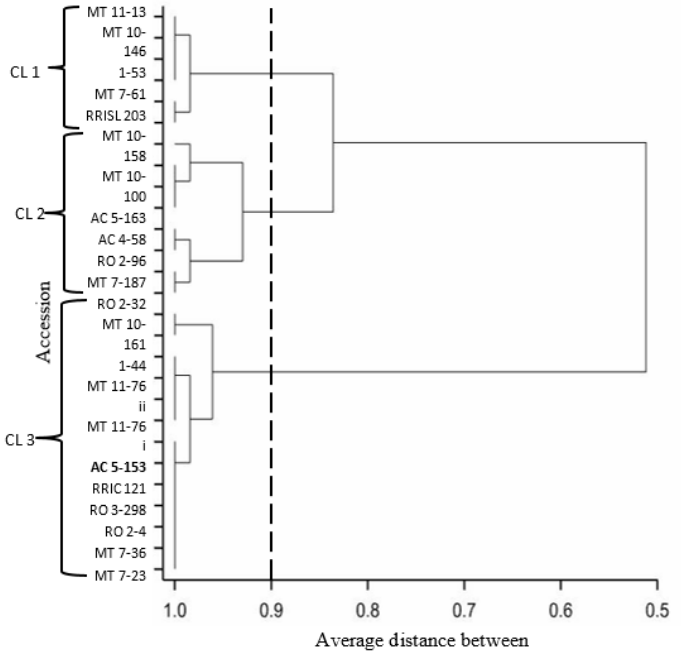


Fig. 5. Dendrogram of 25 accessions and control clones based on average linkage cluster analysis using leaf colour values

(CL 1, CL 2 and CL 3 are the different clusters at an average distance of 0.9)

First cluster consisted of five accessions and control clone RRISL 203 which showed lowest intensity of leaf colour. Also, second cluster followed eight accessions and they have showed higher intensity of leaf colour compared to first cluster but below to the third cluster which consists of twelve accessions and control clone RRIC 121 where showed the highest colour intensity.

Leaf Area

According to results of the Duncan's Multiple Range Test there is no significant difference among accessions and control clones as shown in Table 7.

Table 7. *Means for leaf area of each accession with control clones*

Accession	Mean(cm^2) & DMRT's DMRT's Group
MT 11-88	67.12[a]
MT 11-76 I	66.28[a]
1-53	66.24[a]
MT 11-13	64.98[a]
RRISL 203	63.84[a]
MT 7-187	62.82[a]
RRIC 121	58.94[a]
1-4	58.16[a]
MT 7-23	57.99[a]
AC 6-13	57.50[a]
MT 11-76 II	55.78[a]
MT 7-36	55.77[a]
RO 3-298	55.08[a]
RO 2-32	53.83[a]
AC 4-58	53.80[a]
1-44	53.07[a]
RO 2-4	52.90[a]
MT 10-161	52.79[a]
AC 5-163	52.15[a]
MT 10-100	50.30[a]
RO 3-467	48.75[a]
AC 5-153	48.63[a]
MT 10-158	47.79[a]
RO 2-96	47.17[a]
MT 10-146	46.58[a]
RO 3-300	43.13[a]
MT 7-61	42.52[a]

(Means of the same letter in the column are not significantly different at P≤0.050)

According to Duncan's Multiple Range Test for leaf area, it was clearly seen that there was no any accession which was significantly different each other. Therefore, it may be given minimal contribution to characterize the accession.

However, according to the average linkage cluster analyze, It has shown three main clusters at average distance of 0.9 (Figure 6).

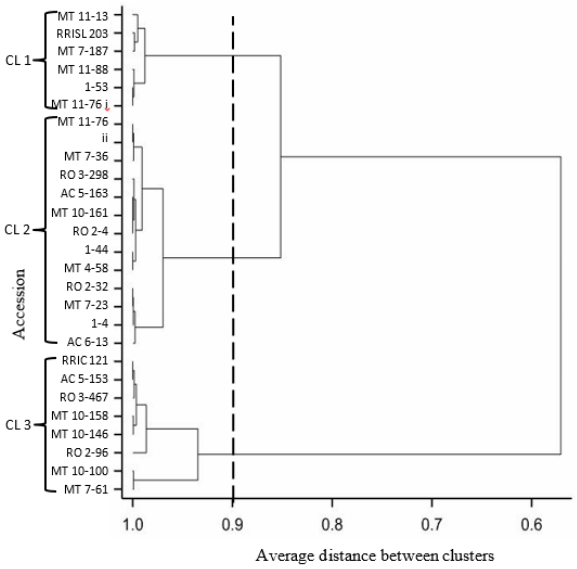


Fig. 6. Dendrogram of 25 accessions and control clones based on average linkage cluster analysis using Leaf area values

(CL 1, CL 2 and CL 3 are the different clusters at average distance of 0.9)

First cluster consisted of five accessions along with the control clone RRISL 203 showed highest leaf area followed by the second cluster consisting of twelve accessions with next control clone RRIC 121. Then third cluster included the rest the accessions which recorded lowest leaf area.

Inter Whorl Length

It was found that the different means of the inter whorl length of these accession and control clones were statistically significant at P≤0.05 which indicated that inter whorl length is significantly different among different accession and control clones as shown in Table 8.

Table 8. *Means for inter whorl length of each accession with control clones*

Accession	Mean(cm) & DMRT's DMRT's Group
MT 10-146	87.53[a]
RO 2-4	85.31[ab]
MT 7-36	75.53[abc]
AC 4-58	73.65[abcd]
MT 7-187	72.1b[cde]
MT 10-100	71.58[bcde]
RO 2-96	71.48[bcde]
RO 2-32	71.28[bcde]
1-53	70.76[bcde]
MT 7-23	69.93[cde]
MT 10-158	66.93[cdef]
RRIC 121	66.73[cdefg]
MT 10-161	66.65[cdefg]
MT 11-13	65.4[cdefg]
1-44	64.36[cdefg]
AC 5-163	63.6[cdefg]
RO 3-300	59.03[defgh]
MT 11-76 II	58.86[defgh]
RO 3-298	57.78[defgh]
RO 3-467	57.33[efgh]
MT 7-61	57.3[efgh]
1-4	56.4[efgh]
MT 11-88	56.11[efgh]
AC 6-13	54.0[fgh]
MT 11-76 I	51.8[fgh]
AC 5-153	51.03[gh]
RRISL 203	46.26[h]

Note: - (Means denoted by the same letter in the column are not significantly different from each other at P≤0.050)

Accession MT 10-146 and RO 2-4 were significantly different from other twenty-one accessions and both control clones. Other accessions were grouped as above. Surprisingly, the control clone RRISL

203 had shown the lowest inter whorl length value.

However, according to the average linkage cluster analyze, three main clusters were identified at an average distance of 0.9 (Figure 7).

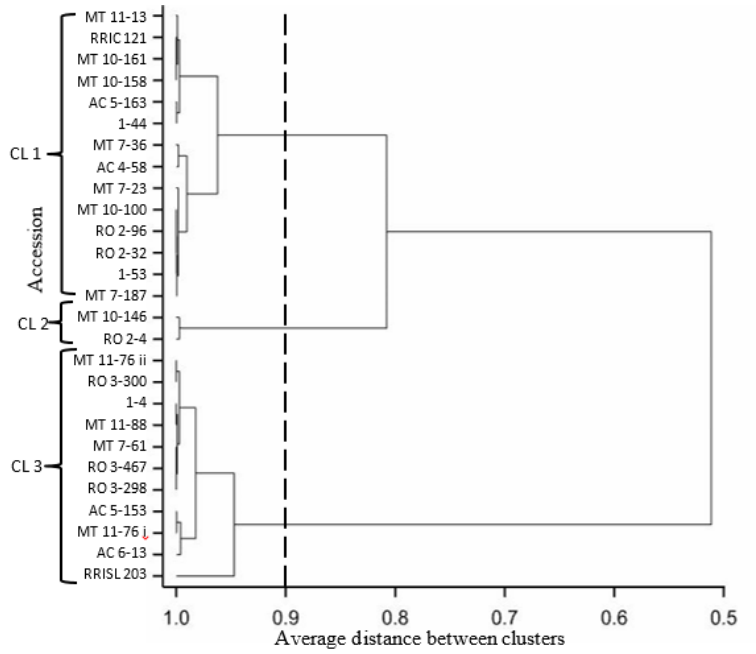


Fig. 7. Dendrogram of 25 accessions and control clones based on average linkage cluster analysis using inter whorl length values

(CL 1, CL 2 and CL 3 are the different clusters at average distance of 0.9)

It was found that the first cluster consists of thirteen accessions and the control clone RRIC 121. Also, they showed higher values than third cluster and lower values of inter whorl length than second cluster. Another the control clone RRISL 203 was grouped into third cluster.

Considering the performances of each accession according to parametric data analysis, it could be found that there were three prominent accessions. For instance, MT 11-76 I, MT 11-76 II and MT 10-146 always showed highest performances for all observations except leaf area, but even accession MT 11-76 I has shown second highest value for leaf area. The time taken for improvement of tree crops through breeding programmes is alarmingly long, compared to that in annual crops. The reason is obviously the

long immature phase of tree crops and therefore, a method for predicting the breeding value of material in the juvenile stage would be one of the most needed inventions in the tree breeding (Gordon and Promnitz, 1976). Therefore, this study will be a better tool for forecasting the breeding value of material in their juvenile stage.

CONCLUSIONS

Varietal selection using morphological and physiological parameters seems to be significant from 1981 *Hevea* germplasm collection. In this study, 25 accessions have been evaluated. According to parameters of leaf area, tree height, girth, chlorophyll content, inter whorl length and leaf colour; some clones exhibit good performances when compared with the control clones, RRISL 203 and RRIC 121.

According to tree height and inter whorl length measurements, accession MT 10-146 showed higher values. Higher chlorophyll content was yielded by the, accession MT 11-76 II whereas the highest girth measurements were observed in, accession MT 11-76 II. Further, from leaf colour measurements, MT 11-76 I and MT 11-76 II showed higher colour rating values and MT 10-146 showed significantly higher values from other accessions. Although accession MT 11-88 showed higher leaf area value, it was not significantly different from other accessions. Therefore, according to parametric data analysis, MT 11-76 I, MT 11-76 II and MT 10-146 exhibit good growth performances compared to control clones. In addition, accession MT 11-13 was also shown good performances than other accessions and two control clones except MT 11-76 I, MT 11-76 II and MT 10-146.

Further, these all four accessions were originated in Cartriquacu district in Mato Grosso state. In addition to above four accession, MT 7-36, AC 6-13, MT 11-88 and RO 2-4 also showed good performances from observed parameters but they could not meet adequate the performance levels of as MT 11-76 I, MT 11-76 II, MT 10-146 and MT 11-13. But those showed better performances than remaining eighteen accessions. However, it is needed to observed for an extended period at bud wood nursery as well as in field conditions to confirm their performances. Also, it is important to evaluate their actual yield figures before go for selections and it will help to find out the correlation of measured characters with their performance.

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REFERNCES

Arzai, A.H. and B.S. Aliyu (2010) The relationship between canopy widths, height and trunk size in some tree species growing in the savana zone of Nigeria, Bayero *Journal of Pure and Applied Sciences*.**3**(1); 260 – 263.

Baddewithana, B.W.A.N.**,** Withanage, S.P**.,** Subasinghe, S. and P. V. A. Anushka (2017)

Characterization of selected accessions of 1981 germplasm of *Hevea* for early growth performance using morphological and physiological parameters. *IOSR Journal of Agriculture and Veterinary Science*. **10** (12); 62 – 75.

Chaudhuri, D., Vinod, K.K., Potty, S.N., Sethuraj, M.R., Pothen, J., Nanja and Y.A. Reddy (1995) Estimation of biomass in *Hevea* clones by regression method: relation between girth and biomass. *Indian Journal of Natural Rubber Research*. **8**(2): 113-116.

Ferguson, H., Cooper, C. S. Brown, J. H. and R. F. Eslick (1972) Effect of Leaf Color, Chlorophyll Concentration, and Temperature on Photosynthetic Rates of Isogenic Barley Lines. *Agronomy journal*. **64**(5): 671-67.

Gordon, J. C., Promnitz, L. C., 1976. Photosynthetic and enzymatic criteria for the early selection of fast-growing Populous clone. In: Tree Physiology and Yield Improvement. Eds. M. G. R. Cannell and F. T. Last, p. 567, Academic Press London, New York, San Francisco.

Karunaratne, M.A.S., Wijeratne, A.W. and J.B.D.A.P. Kumara (2005). Linear Estimation of Girth as a Covariate on Yield Parameters of Rubber (*Hevea brasiliensis* Muell.Arg.): Correlation of Girth with Latex Volume and Weight. *The journal of Agricultural Science.* Sabaragamuwa university of Sri Lanka, Agri. **l** (1); 7-10.

Liyanage, K. K., (2007) *Hevea* germplasm and it's potential. *Bulletin of Rubber Research Institute of Sri Lanka*. **48**; 16-26.

Martinez, L., Masuelli, R., and J. Rodriguez (2003) Evaluation of diversity among Argentine grapevine (*Vitis vinifera* L.) varieties using morphological data and AFLP markers. *Electronic journal of Biotechnology*. **6**(3); 245-250

Nugawela, A., Ariyawansa, P. and Samarasekara, R.K. (1995) Physiological yield determinants of sun and shade leaves of *Hevea brasiliensis. Journal of Rubber Research Institute of Sri Lanka.* **76**; 1-10.

Nugawela, A., (1998) Yield decline in plantation can excessive double tapping be a course? *Bulletin of Rubber Research Institute of Sri Lanka*. **38**: 43-49.

Onokpise, O.U. (2004) Natural rubber *Hevea brasiliensis* germplasm (Willd.ex A. Juss.) Mull.Arg, collection in the Amazon Basin, Brazil: A retrospective. *Journal of Economic Botany* **58**: 544-555.

Perera, S.A.C.N. and W.M.U. Fernando (2000) Multivariate discrimination of coconut germplasm using inflorescence morphological character, *Proc.57th Annual session of Sri Lanka association for the advancement of science*, Part I, 97p.

Senevirathna, A.M.W.K., Stirling, C.M. and V.H.L. Rodrigo (2003) Growth, photosynthetic performance and shade adaptation of rubber (*Hevea*

brasiliensis) grown in natural shade. *Tree Physiology*. **23** ;705–712.

Statistics solutions, (2015) kruskal-wallis-test. [Online] Available at: https://www.statisticssolutions.com/kruskal-wallis-test. [Accessed on 25 January 2015].

Withanage, S. P., Attanayake, D. P. S. T. G., Jayasekara, N. E. M., Liyanage, K. K., Karunasekara, K. B. and I. D. M. J. Sarath Kumara (2015) Evaluation and utilization of the *Hevea* germplasm collected from 1981 IRRDB expedition to the Amazon; a review. *Journal of the Rubber Research Institute of Sri Lanka*. **95**;24-38.

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