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Phenotypic Diversity of Rubber Clones Grown in Sri Lanka at their Immature Stage Based on the Available Morphological Descriptors

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ABSTRACT. *Proper identification of rubber clones plays a vital role in crop management system and research. Although many clones do not exhibit highly distinct variations, most of them possess differences in certain minor, but more or less stable morphological features, which can be used for identification. Objectives of this study were to estimate morphological diversity present in the rubber clones at their immature stage and to determine the importance of different descriptors in categorizing different clones into distinct groups. Thirty eight clones were characterized using 29 standardized morphological descriptors. Principal component analysis (PCA) using 29 descriptors showed that 26 out of 29 descriptors were informative and contribute significantly ($p<0.05$) to the variation among the clones selected. Cluster analysis based on significant principal components further revealed that characters of leaf, petiole and leaf scar were the most discriminating descriptors in distinguishing the clones into phenotypically diverse groups. This study identifies the morphological descriptors that are most important for characterization of rubber clones grown in Sri Lanka.*

Keywords: *Phenotypic diversity, rubber clones, morphological descriptors, Sri Lanka*

INTRODUCTION

Use of genetically improved high yielding planting materials of rubber in Sri Lanka has achieved spectacular growth in the area of plantation, production and most notably the productivity during the past years (Anon, 2010). These developments were achieved pursuant to a well conceived research and development program, notably a systematic crop improvement program coupled with efficient extension and research activities. Rapid adoption of locally bred new clones has contributed substantially to reach high yield levels both in estate and small holding sector in the country.

Proper identification of these clones plays a vital role in crop management system and research. Knowledge of relatively consistent characteristics of a clone either singly or in combination will enable planters to conveniently identify different clones recommended for planting. Although clones do not exhibit highly distinct variations, most of them possess certain minor, but more or less stable morphological features, which can be used upon for

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identification. But, expression of those characters is necessarily the result of interaction of genotype with an environment in a different magnitude. Hence, it is always desirable to consider those traits that are least influenced by the environment for identification of clones. It will help them to make sure that the right clones are procured and used for planting. Use of morphological markers is cost effective when compared to the use of biochemical and molecular markers for preliminary characterization of large number of accessions (Martinez *et.al*., 2003) and to identify morphologically similar groups and for simple varietal identification of phenotypically distinguishable cultivars. All the clones recommended for planting need to be characterized using a standard set of descriptors. Morphological classification for rubber is done based on the set of descriptors first suggested by Dijkman (1951), then followed by Jayasekara *et al.* (1984), and Mercykutty *et al*. (1991). However, the use of minimum but important list of descriptors would help save resources as characterizing the entire recommended clones using all possible descriptors requires more resources. Therefore, it is necessary to identify critical descriptors which have high discriminating ability relevant to a particular clone.

Multivariate statistical techniques such as principal component analysis and cluster analysis are the commonly used methods for characterization and genetic diversity analysis of perennial crops such as tea (Wickramaratne, 1981, Gunasekara *et al.,* 2001) coconut (Kumaran *et al*., 2000), cocoa (Bhat *et al*., 2000). However, in rubber, a number of morphological studies was reported in all rubber producing countries (De Silva and Sachuthananthavale, (1961), Paardikooper, (1965), Jayasekara *et al*., (1984), Mercykutty *et al.,* (1991, 2002), Penot and Rasidin, (1994) and Michel and Beningo, (1994)), all these studies were confined to collection of morphological data for identifying the clones. There is no evidence on conducting statistical analysis for characterization of clones based on their morphological descriptors. Therefore, the objective of the present study was to identify key morphological features contributing to the total phenotypic variation of the recommended rubber clones in Sri Lanka at their immature stage.

MATERIALS AND METHODS

Thirty eight clones of the 100 series, 200 series, 2000 series and eight foreign selections recommended by the Rubber Research Institute of Sri Lanka (RRISL) (Attanayake, 2001) for planting both at estate sector and small holder sector were selected (Table 01).

Table 1. Clones recommended for planting by the Rubber Research Institute of Sri Lanka

100 Series	200 Series		2000 Series	Foreign Clones
RRIC 100	RRISL 201	RRISL 218	RRISL 2000	PB 28/59
RRIC 102	RRISL 203	RRISL 219	RRISL 2001	PB 217
RRIC 121	RRISL 205	RRISL 220	RRISL 2002	PB 235
RRIC 130	RRISL 206	RRISL 221	RRISL 2003	PB 255
RRIC 133	RRISL 208	RRISL 222	RRISL 2004	PB 260
	RRISL 210	RRISL 223	RRISL 2005	RRIM 712
	RRISL 211	RRISL 225	RRISL 2006	PB 86
	RRISL 215	RRISL 226		PR 305
	RRISL 217	RRISL 216		

Experimental Design

This experiment was carried out at the Genetics and Plant Breeding Department, RRISL, Mathugama, situated at the low country wet zone at an elevation of 11m above mean sea level. The annual rain fall of the area was about 3200 mm and it had red yellow podsolic soil series. Both dry spells as well as scattered heavy rainfall observed during study period.

Budded stumps of selected clones were planted in poly bags. The plants raised in the bags were transplanted into the field after six-month of growth in a completely randomized block design. The spacing adopted was 3' x 3'. The most suitable period for the identification of clones was when the budded plant is about 12 to 18 months in the nursery. Characters were recorded from fifteen plants five each randomly selected from three replicates. Data were collected from the top most mature flush of the leaf whorl. Fifteen fully expanded leaves one each from different plant of each clone were used for quantifying descriptors related to leaflets and petioles. Three leaflets of each leaf were measured using a leaf area meter.

Data collection

All the descriptive morphological descriptors were recorded in the data sheet formatted when the plants were in fifteen months of age. As the descriptors used in the study consisted of parametric and non-parametric data and hence, the variables were measured using different units on different scales.

Morphological measurements on the following parameters were collected.

a. Nodes - Axilarry buds and the leaf scars were considered under this parameter. Leaf scar was the mark which left after the leaf shedding. They were normally flat in certain clones and some were prominent with pronounced margin. Shapes of the scares in generally vary from heart shape to circular (Fig. 1).

a - Heart shape and flat scar

b- Circular and protruded scar

Fig.1. Type of leaf scars:

b. Leaf storey – The shape, nature of separation and the external appetence of leaf storey were considered. The shape of the leaf storey measures the appearance of the leaf bearing part of the stem. When the leaf bearing part was viewed from a distance, there were four different shape of stories; hemispherical (globular), bow shape, conical and truncate shape (Fig. 2). The separation of leaf storey was considered as the presence of bare stem which separate leaf story of a plant. Different clone show variation in the pattern of separation such that differentiation between two successive whorls was comparatively less noticeable where as in others they were well separated. In some clones diffuse distribution of leaves in between two whorls could be observed *i.e.* stem bearing leaves over its entire length (Fig. 3).

a - **Hemispherical** b - **Bow shape** C - **Conical** d - **Truncate**

Fig. 2. Shape of the leaf storey

a - **Not well separated** b - **Well separated** c - **Diffuse**

Fig. 3. Separation of leaf storey

c. Petiole and petiolule - pulvinus, shape, size, orientation, angle and size of petiol were considered under this category. Accordingly, the shape of petiole was fall in to four categories *viz*. the basal portion shaped like an arch (arched) no bending or curving of the petiole (straight). The middle portion of the petiole angled downward (concave). "S" shape petiole having convex bend at the basal portion and concave bend at the distal end. (Fig. 4)

a - **Arched** b - **Straight**

c - **Concave** d - **S" shape**

Fig. 4. Shape of petiole

d. Leaves – The characters such as colour, lusture, texture, shape and size, cross section & longitudinal section appetence, leaf apex, leaf base, leaf margin and degree of separation were considered under this parameter. The leaflet characters also shared a number of variations. Leaf apex was very important feature for identification of clones. Usually, the mature middle leaflet was used for observations. There were commonly found four types of leaf apices; namely aristate, acuminate, cuspidate and apiculate. Aristate apex tapers to a very narrow elongated tip, whereas acuminate apex refers to an acute tip with concave sides that tapers somewhat into an elongated tip. Cuspidate apex is somewhat sharply concave and ends abruptly and apiculate the leaflets were characterized by a short tip (Fig. 5).

a **- Aristate** b **- Acuminate** c **- Capsidate** d **- Apiculate**

Fig. 5. Shape of leaflet apex

Data analysis

Non parametric data were converted on a scale of numeric data to enable them to be used in statistical analysis. Principal Component Analysis (PCA) was carried out using mean values of morphological characters. Cluster analysis was performed based on significant Principal Components (PC) using SAS – Version 9.2 (Annon, 2008).

RESULTS AND DISCUSSION

Eigenvalues of the correlation matrices obtained from the PCA of the 29 morphological descriptors are given in the Table 2. Eigenvalues of the first 11 principal components (PCs) were greater than one, indicating that those 11 PCs significantly contributed to the variation existing among the clones studied. Furthermore, those 11 PCs accounted for 78% of the total variation.

The means of morphological data used for characterization of the rubber clones in this study are presented in Appendix I.

Table 2. Eigen values of the correlation matrices obtained from the Principal Component Analysis of 29 morphological descriptors

PC	Eigen value	Difference	Proportion	Cumulative
1	3.721	0.827	0.1329	0.1329
2	2.894	0.565	0.1034	0.2363
3	2.329	0.157	0.0832	0.3195
4	2.171	0.113	0.0776	0.3971
5	2.058	0.093	0.0735	0.4706
6	1.964	0.227	0.0702	0.5407
7	1.736	0.257	0.0620	0.6028
8	1.479	0.159	0.0528	0.6556
9	1.319	0.105	0.0471	0.7027
10	1.214	0.105	0.0434	0.7461
11	1.108	0.158	0.0396	0.7857
12	0.949	0.068	0.0339	0.8196
13	0.881	0.064	0.0315	0.8511
27	0.041	0.024	0.0015	0.9994
28	0.017	0.01 7	0.0006	1.0000
29	0.000		0.0000	1.0000

Table 3 shows that values of the eigenvectors of some of the variables (which are highlighted) are comparatively higher than the other variables. Although all the twenty-nine variables have contributed to a certain degree in deciding the position of each of the first eleven principal components, it is clearly evident that some of the variables play comparatively significant role in deciding the position of each PC indicating that they are the main contributors in each component.

Table 3. Eigen vector for first eleven PCs of 29 morphological descriptors

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11
1	-0.003025	-0.149198	0.144271	-0.054837	0.173241	**-0.421100**	0.215167	-0.188730	0.045579	0.255207	0.245187
2	0.174030	-0.114272	-0.045188	-0.198800	-0.106479	-0.246059	0.225938	**0.392417**	0.053709	-0.016943	0.200509
3	-0.132007	0.191337	**0.399406**	-0.011409	-0.077527	0.027763	-0.240431	**0.339358**	-0.089241	0.014650	0.103607
4	-0.076389	-0.088755	0.103792	-0.047503	0.280403	**0.453320**	-0.109414	0.085559	-0.027641	-0.284200	0.035153
5	-0.121415	-0.084371	0.179562	**-0.333479**	0.139028	-0.032152	**-0.345237**	-0.200997	0.190776	-0.117875	0.000444
6	0.180579	0.180931	-0.243923	-0.182928	0.058733	-0.085549	-0.208014	-0.099544	-0.071563	**0.351979**	-0.156459
7	0.225583	0.081611	0.288289	-0.086037	**0.309058**	0.038809	0.211875	0.213143	-0.239799	-0.052354	0.150854
8	-0.207464	0.134519	-0.061189	0.098140	**0.323486**	0.172721	0.217767	0.190342	0.102965	**0.409735**	0.095881
9	0.258088	-0.114366	0.048988	0.083470	-0.208177	0.110060	0.316151	-0.066055	**0.356448**	-0.101314	0.083584
10	0.173276	0.262861	0.179352	-0.073566	**0.347336**	0.010062	0.293712	-0.037211	0.039228	-0.116529	-0.014009
11	0.236583	-0.242321	0.144331	-0.040537	0.081144	0.085197	-0.173190	-0.076501	-0.272374	0.127938	-0.272407
12	-0.288269	-0.111276	0.017730	0.155902	0.159322	-0.059304	0.080210	-0.060322	**0.360666**	0.062810	-0.266223
13	-0.149498	-0.008448	-0.128418	-0.081767	-0.050703	**0.326701**	**0.370752**	-0.004766	**-0.402020**	0.166452	-0.262098
14	0.204699	0.268602	0.056497	**-0.311885**	-0.017456	0.144317	0.112299	-0.049194	0.162195	0.094806	**-0.327556**
15	0.050182	0.127000	0.122518	**0.363758**	0.246748	0.066007	-0.065216	0.134929	**0.359069**	-0.101244	-0.246954
16	-0.074416	**0.405433**	-0.282130	0.027350	-0.010931	0.000058	0.053798	-0.024015	0.049995	-0.050955	0.125974
17	0.004727	**0.408540**	0.077471	-0.155733	0.030320	-0.211005	-0.128710	-0.191165	-0.017246	-0.193889	0.101045
18	-0.112296	**0.391055**	0.116360	0.109309	-0.047393	0.071585	-0.005326	-0.181447	-0.021378	0.067696	0.144280
19	**0.339013**	-0.108543	-0.100579	0.204006	0.088577	0.031617	-0.228024	0.140367	-0.035264	0.051405	0.053896
20	0.042766	0.159255	-0.050692	**0.416350**	-0.111981	-0.159119	0.140036	-0.288182	-0.224305	-0.200611	-0.186216
21	-0.035554	0.022577	**0.337525**	0.203278	**-0.375055**	-0.072683	0.140803	0.187420	-0.059594	-0.129468	-0.089370
22	0.270627	0.044824	-0.231669	-0.046194	-0.110769	0.348982	-0.018948	-0.078890	0.072013	-0.282152	0.183201

Table continued on next page

23	0.186250	0.190443	-0.181030	0.085168	-0.140837	-0.052672	-0.191264	**0.412833**	0.211174	0.213996	-0.158980
24	0.062086	0.010745	0.115263	0.081191	-0.226484	**0.360491**	-0.040662	-0.213552	0.136608	**0.359232**	**0.458622**
25	-0.073498	0.050947	**0.339150**	0.181395	-0.156273	0.103686	-0.153490	-0.082848	-0.085472	0.266297	-0.039571
26	**-0.304916**	0.162521	-0.144076	-0.129068	-0.123371	-0.029362	-0.049035	0.282540	-0.165361	-0.114782	0.053545
27	-0.251895	-0.132773	-0.274190	0.230448	0.224313	0.012033	-0.082560	0.054762	-0.072829	-0.095598	0.238817
28	**-0.304773**	-0.084085	0.037523	**-0.326938**	-0.231673	0.117210	0.137271	0.013260	0.245378	-0.044595	-0.137621
29	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

1 - Axillary bud,
2 - Leaf scar
3 – Shape of leaf scar
4 - Shape of leaf storey
5 -Separation of leaf storey
6 - Ext. appearance of leaf storey
7 - Size and width of leaf storey
8 – Pulvinus
9 - Petiole shape
10 - Petiole size
11 – Petiole orientation
12 – Petiolue orientation
13 – Petiolule angle
14 – Petiolule size
15 – Petiolule junction appearance
16 – Leaflet colour
17 – Leaflet luster
18 – Leaflet texture
19 – Leaflet shape
20 – Leaf area
21 – Leaflet thickness
22 – Leaf margin
23 – Degree of leaflet separation
24 – Cross sectional appearance
25 – Longitudinal sectional appearance
26 – Shape of leaf apex
27 – Shape of leaf base
28 – Colour of veins
29 – Nature of veins

When explaining the above patterns of the 29 variables it was clear that 26 variables have contributed significantly to decided the positioning of the first eleven PCs and ultimately to the variation (Table 4). Only three variables were found comparatively less significant. They were shape of petiolule orientation, shape of leaf base and nature of veins.

Table 4. Main contributor descriptors for each principal component (PC)

PC	Main Descriptors
1	Leaflet shape, Shape of leaf apex, Colour of veins
2	Leaflet colour, leaflet luster, leaflet texture
3	Shape of leaf scar, longitudinal sectional appearance of leaf
4	Petiolule junction appearance, leaf area, Colour of veins,
5	Size and width of leaf storey, petiole size, Leaflet thickness
6	Type of axillary bud, Shape of leaf storey, Shape of leaf margin
7	Separation of leaf storey
8	Type of leaf scar, Degree of leaflet separation
9	Petiole shape, Petiolue orientation, Petiolue angle
10	External appearance of leaf storey, Type of pulvinus
11	Petiolule size, Cross sectional appearance of leaf

Based on the results of PC analysis, the number of descriptors (or combinations of descriptors) could be reduced in the form of principal components. In order to achieve the main objective of grouping the accessions, cluster analysis was performed based on average linkage on the first eleven principal components.

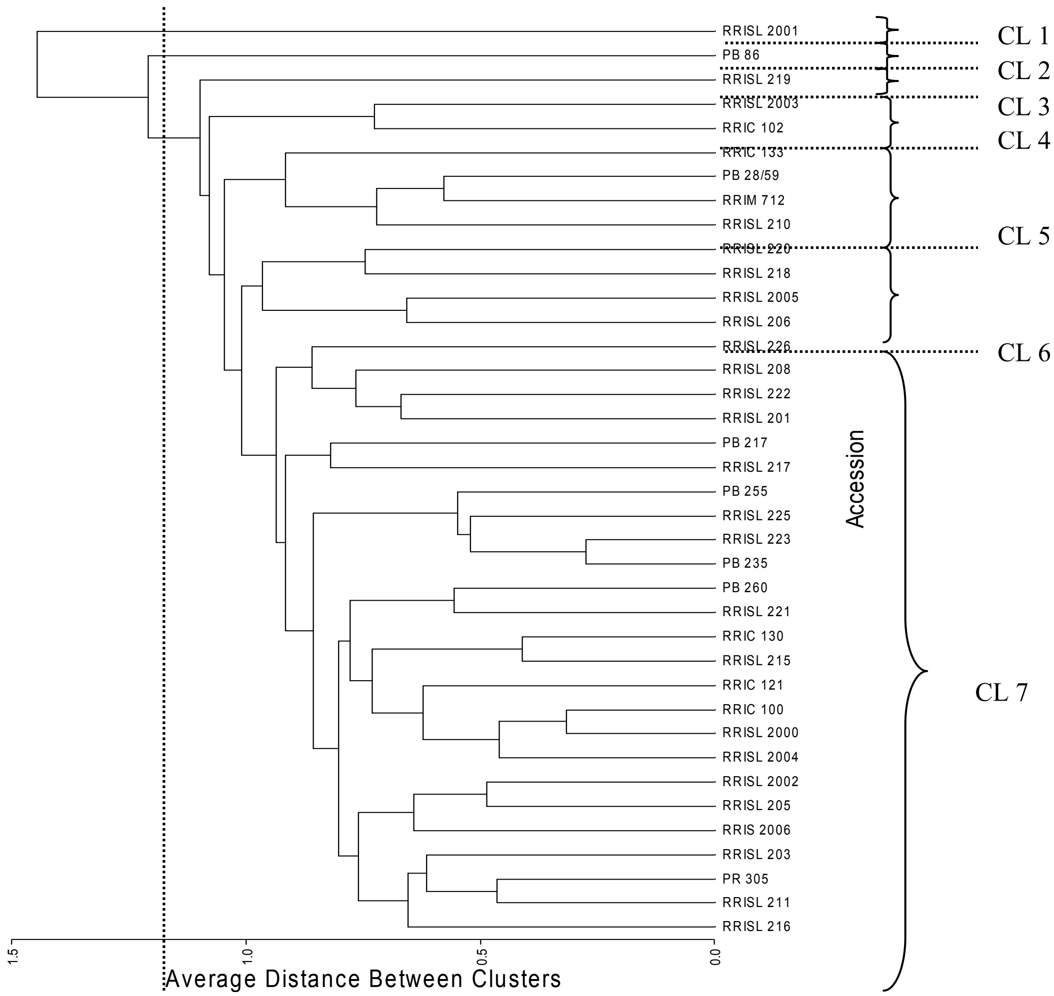

Fig. 6. Dendrogram of 38 rubber clones based on average linkage cluster analysis using 29 morphological descriptors
(CL 1 to CL 7 is the different clusters at average distance of 1.0)

The dendrogram (Fig. 6) indicates that the 38 rubber clones used in this study were grouped into seven well defined clusters at the average distance of 1.0. The cluster compositions of different clones based on their 29 morphological descriptors are given in the Table 5.

Table 5. The cluster composition of different clones based on the morphological descriptors.

Cluster No.	Number of clones	Clone name
1	01	RRISL 2001
2	01	PB 86
3	01	RRISL 219
4	02	RRISL 2003, RRIC 102
5	04	RRIC 133, PB 28/59, RRIM 712, RRISL 210
6	04	RRISL 220, RRISL 218, RRISL 2005, RRISL 206
7	25	RRISL 226, RRISL 208, RRISL 222, RRISL 201, PB 217, RRISL 217, PB 255, RRISL 225, RRISL 223, PB 235, PB 260, RRISL 221, RRIC 130, RRISL 215, RRIC 121, RRIC 100, RRISL 2000, RRISL 2004, RRISL 2002, RRISL 205, RRISL 2006, RRISL 203, PR 305, RRISL 211, RRISL 216

Schematic diagram for the illustration of the morphological features responsible for the cluster divergence is present in the Fig. 6.

As depicted, cluster I, consist only one clone RRISL 2001 and it was clearly separated from others because it had a unique morphological feature like circular shape leaf scars and, it process distinct, though not unique features like broad elliptical shape leaflets, smooth leaf margin, arched shape petiole, apiculate leaf apex and it had leaflets with “S” shape in the longitudinal sectional appearance.

The cluster II consists only of PB 86, which is a primary clone introduced from Malaysia. The clone PB 86 also had some discriminating morphological features such as normal pulvinus, conical shaped leaf storey, “S” shaped petiole and obovate shaped leaflet.

Cluster III includes only one clone RRISL 219 which differs significantly from other clones for the combination of characters such as upward orientation of petiloule, broad elliptical shape leaf storey, strait appearance of the petiolule junction and touching habit of the leaflet in leaflet separation character.

Cluster IV includes two clones RRISL 2003 and RRIC 102. These two clones have common features of conical shape leaf storey, broad elliptical shape leaflets and thin (thickness) leaflets which help to form a separate cluster. Within the cluster those two clones could be separated at their shape of the petiole, degree of leaflet separation, shape of the leaf apex and leaf base.

Cluster V consists of four clones, RRIC 133, PB 28/59, RRIM 712, RRISL 210, which posses bigger petiolule, dark colour leaflets, Glossy luster and smooth texture than other clones which help in the formation of a separate cluster.

Cluster VI consists of four clones, RRISL 220, RRISL 218, RRISL 2005, RRISL 206. The main criteria for the cluster formation is that all posses normal pulvinus while others have swollen type pulvinus. Within the cluster, there were some differences exist among the clones.

The remaining 25 clones formed one big cluster (Cluster VII). Most of the clones possess similar traits due to lower genetic diversity as they were derived from common ancestors. Although clones belong to this cluster do not exhibit highly distinct variations, most of them possess certain minor, but more or less stable morphological features, which can be used for identification. Therefore, the extent of the morphological diversity among the clones along, do not reflect the genetic diversity of *Hevea* clones necessarily enough and the use molecular markers along with the morphological markers are necessary for clear identification of the existing clones.

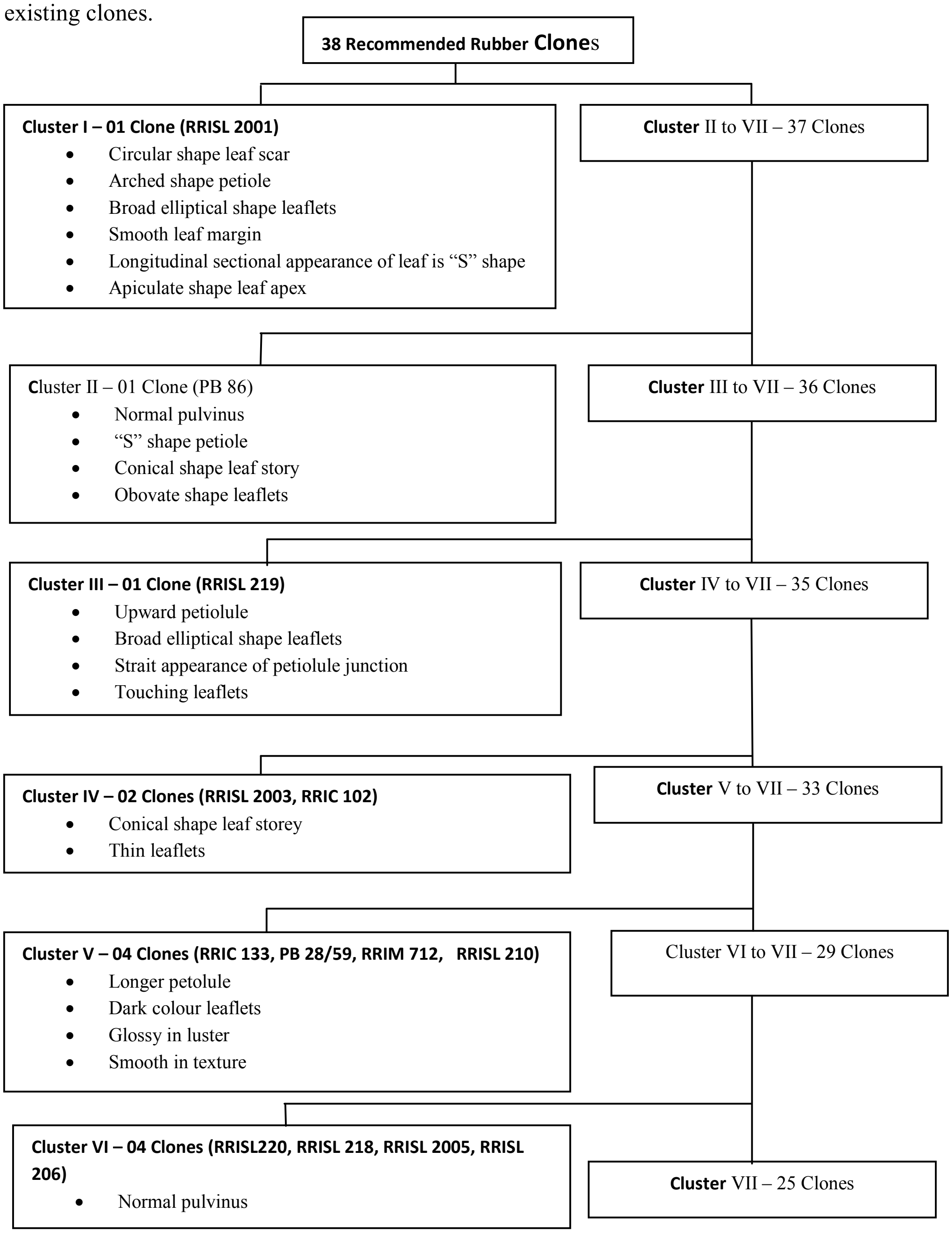

Fig. 7 Schematic diagram illustrating the discriminating morphological features responsible for the cluster divergence

The present analysis of morphological characters provides the basis for broad classification of rubber clones, PCA identifies the variables contributing to most of phenotypic diversity while clustering helps in identifying groups of clones according to the degree of relationship to each other defined by their common morphological features.

CONCLUSIONS

This study classified the 38 rubber clones recommended to grow in Sri Lanka into well defined phenotypic groups. Principal component analysis using 29 morphological descriptors and cluster analysis based on first 11 principal components grouped 38 clones into seven major clusters. Among all 29 descriptors measured, 26 descriptors highly contributed to the phenotypic diversity of the clones. Analysis of morphological characters provides the basis for broad classification of rubber clones and principal component analysis could identify the variables contributing most to the phenotypic diversity of the clones.

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Appendix I

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
RRISL216	3.0	2.0	1.0	3.0	1.0	3.0	88.8	2.0	4.0	29.0	1.0	2.0	50.0	2.3	2.0	4.0	1.0	1.0	2.0	113.8	2.0	3.0	3.0	3.0	2.0	2.0	1.0	2.0	1.0
RRISL206	2.0	2.0	1.0	4.0	1.0	1.0	81.2	1.0	4.0	25.0	2.0	1.0	49.2	1.7	1.0	1.0	1.0	1.0	3.0	114.4	2.0	3.0	2.0	3.0	2.0	3.0	1.0	2.0	1.0
RRIS2004	2.0	1.0	1.0	4.0	2.0	1.0	78.4	2.0	2.0	25.7	1.0	3.0	58.4	1.4	2.0	4.0	1.0	1.0	1.0	136.5	1.0	3.0	2.0	2.0	1.0	2.0	3.0	2.0	1.0
RRISL218	3.0	1.0	1.0	3.0	3.0	3.0	83.7	1.0	2.0	23.8	2.0	1.0	50.5	1.3	1.0	2.0	1.0	1.0	2.0	119.0	1.0	3.0	2.0	3.0	2.0	2.0	1.0	2.0	1.0
RRIS2006	3.0	2.0	1.0	1.0	1.0	1.0	91.6	2.0	2.0	24.7	2.0	2.0	51.2	1.6	1.0	1.0	1.0	1.0	3.0	104.0	1.0	1.0	3.0	3.0	1.0	1.0	1.0	2.0	1.0
RRISL211	3.0	2.0	1.0	3.0	2.0	2.0	78.3	2.0	2.0	22.0	1.0	2.0	43.8	2.0	2.0	2.0	1.0	1.0	2.0	120.2	1.0	3.0	3.0	2.0	1.0	2.0	1.0	2.0	1.0
RRISL215	2.0	2.0	1.0	4.0	2.0	3.0	84.1	2.0	1.0	25.1	2.0	2.0	48.8	1.5	2.0	2.0	1.0	1.0	2.0	99.4	1.0	3.0	3.0	2.0	1.0	4.0	3.0	2.0	1.0
RRIC121	2.0	2.0	1.0	4.0	1.0	1.0	76.8	2.0	4.0	21.7	1.0	2.0	57.9	1.2	2.0	2.0	1.0	1.0	2.0	111.8	1.0	3.0	3.0	3.0	1.0	4.0	1.0	2.0	1.0
RRISL217	3.0	2.0	1.0	1.0	1.0	3.0	79.8	2.0	2.0	25.5	1.0	2.0	62.9	1.6	1.0	4.0	1.0	1.0	1.0	114.6	1.0	1.0	3.0	2.0	1.0	4.0	1.0	2.0	1.0
RRISL201	3.0	1.0	1.0	4.0	2.0	3.0	77.1	2.0	2.0	23.9	2.0	3.0	45.9	1.5	2.0	2.0	2.0	2.0	2.0	124.2	1.0	1.0	2.0	3.0	2.0	2.0	1.0	2.0	1.0
PB235	3.0	1.0	1.0	4.0	1.0	3.0	91.6	2.0	3.0	27.6	2.0	2.0	52.1	1.3	2.0	2.0	1.0	1.0	4.0	132.2	1.0	3.0	3.0	3.0	2.0	1.0	3.0	1.0	1.0
RRISL210	2.0	1.0	1.0	4.0	1.0	3.0	74.9	2.0	2.0	32.5	1.0	2.0	55.5	2.2	2.0	9.0	2.0	2.0	1.0	145.3	1.0	3.0	3.0	3.0	1.0	4.0	1.0	2.0	1.0
RRISL225	2.0	1.0	1.0	3.0	1.0	2.0	92.5	2.0	2.0	26.3	2.0	2.0	48.5	1.1	2.0	2.0	1.0	2.0	1.0	131.1	1.0	3.0	2.0	3.0	2.0	2.0	1.0	1.0	1.0
RRIS2000	2.0	1.0	1.0	4.0	1.0	1.0	79.7	2.0	3.0	24.1	1.0	2.0	58.4	1.3	2.0	2.0	1.0	2.0	2.0	122.7	1.0	3.0	3.0	3.0	1.0	2.0	3.0	2.0	1.0
RRIS2005	2.0	1.0	1.0	4.0	1.0	1.0	85.3	1.0	3.0	23.4	2.0	2.0	55.2	1.3	2.0	3.0	1.0	1.0	3.0	150.1	2.0	3.0	3.0	2.0	1.0	2.0	1.0	2.0	1.0
RRISL221	2.0	1.0	1.0	3.0	1.0	3.0	69.6	2.0	2.0	23.6	1.0	2.0	51.5	1.7	2.0	6.0	1.0	1.0	3.0	121.9	1.0	3.0	3.0	3.0	3.0	2.0	1.0	2.0	1.0
RRISL220	2.0	1.0	1.0	1.0	2.0	3.0	62.4	1.0	2.0	19.0	1.0	2.0	46.0	1.9	1.0	2.0	2.0	1.0	2.0	120.5	1.0	3.0	3.0	3.0	1.0	2.0	1.0	2.0	1.0
RRIC130	2.0	1.0	1.0	4.0	2.0	3.0	81.1	2.0	2.0	25.4	2.0	3.0	57.0	1.4	2.0	2.0	1.0	1.0	3.0	115.9	1.0	1.0	3.0	2.0	1.0	4.0	3.0	2.0	1.0
PR305	2.0	1.0	1.0	3.0	2.0	3.0	85.8	2.0	3.0	25.9	2.0	2.0	46.9	1.8	2.0	2.0	1.0	1.0	2.0	109.9	1.0	3.0	3.0	3.0	1.0	2.0	1.0	2.0	1.0
RRIC100	2.0	1.0	1.0	4.0	1.0	1.0	82.4	2.0	2.0	27.8	1.0	3.0	52.5	1.0	2.0	4.0	1.0	1.0	2.0	112.6	1.0	3.0	2.0	3.0	1.0	2.0	3.0	2.0	1.0
RRISL203	2.0	1.0	1.0	4.0	1.0	1.0	77.1	2.0	4.0	26.8	2.0	3.0	51.1	1.9	2.0	2.0	1.0	1.0	2.0	126.1	1.0	3.0	3.0	3.0	3.0	2.0	1.0	2.0	1.0
PB217	3.0	1.0	1.0	4.0	1.0	3.0	85.9	2.0	2.0	27.8	1.0	1.0	49.7	1.1	1.0	7.0	2.0	1.0	2.0	106.7	1.0	3.0	3.0	3.0	1.0	4.0	3.0	2.0	1.0
PB260	2.0	1.0	1.0	1.0	1.0	3.0	67.0	2.0	3.0	19.3	1.0	3.0	56.7	1.3	1.0	4.0	1.0	2.0	2.0	120.4	1.0	3.0	3.0	3.0	1.0	4.0	3.0	2.0	1.0
RRISL219	2.0	1.0	1.0	4.0	1.0	3.0	90.9	2.0	2.0	26.4	2.0	1.0	84.8	2.1	1.0	2.0	1.0	1.0	1.0	127.4	1.0	3.0	2.0	3.0	1.0	2.0	1.0	2.0	1.0
RRIC133	2.0	2.0	1.0	1.0	1.0	3.0	97.3	2.0	2.0	28.3	1.0	1.0	49.3	1.9	2.0	7.0	2.0	2.0	3.0	154.7	1.0	3.0	3.0	2.0	1.0	3.0	1.0	1.0	1.0
RRISL205	3.0	2.0	1.0	4.0	2.0	1.0	83.3	2.0	3.0	25.5	2.0	2.0	55.2	1.4	1.0	1.0	1.0	1.0	2.0	127.9	1.0	3.0	2.0	3.0	2.0	3.0	1.0	2.0	1.0
RRISL222	3.0	1.0	1.0	4.0	3.0	1.0	71.2	2.0	2.0	23.7	1.0	2.0	40.2	0.9	2.0	4.0	1.0	1.0	1.0	118.7	1.0	1.0	2.0	3.0	1.0	3.0	3.0	2.0	1.0

RRISL208	3.0	1.0	1.0	4.0	2.0	1.0	97.6	2.0	2.0	29.3	1.0	3.0	54.2	1.7	2.0	2.0	1.0	1.0	2.0	84.5	1.0	1.0	2.0	2.0	1.0	2.0	1.0	2.0	1.0
RRIC102	3.0	1.0	1.0	1.0	1.0	1.0	73.1	2.0	2.0	21.4	1.0	3.0	59.3	0.8	2.0	4.0	1.0	2.0	1.0	165.1	2.0	1.0	2.0	3.0	3.0	4.0	3.0	2.0	1.0
RRISL2002	3.0	2.0	1.0	4.0	1.0	1.0	85.3	2.0	3.0	23.5	1.0	3.0	52.6	1.0	1.0	2.0	1.0	1.0	2.0	111.3	1.0	3.0	2.0	3.0	1.0	2.0	3.0	2.0	1.0
RRISL223	3.0	1.0	1.0	4.0	1.0	3.0	78.3	2.0	2.0	26.6	2.0	2.0	51.2	1.7	2.0	2.0	1.0	1.0	4.0	126.3	1.0	2.0	3.0	3.0	2.0	1.0	2.0	1.0	1.0
RRIM712	2.0	1.0	1.0	4.0	2.0	1.0	86.9	2.0	2.0	26.7	1.0	2.0	50.7	2.3	1.0	4.0	2.0	2.0	2.0	121.0	1.0	3.0	3.0	3.0	2.0	2.0	1.0	2.0	1.0
RRISL2001	2.0	1.0	2.0	4.0	2.0	1.0	93.0	2.0	1.0	26.2	1.0	2.0	47.3	1.5	2.0	2.0	2.0	2.0	1.0	107.0	2.0	1.0	3.0	3.0	3.0	4.0	1.0	2.0	1.0
PB255	2.0	1.0	1.0	4.0	1.0	1.0	84.6	2.0	2.0	22.6	1.0	1.0	49.0	1.5	2.0	2.0	1.0	1.0	5.0	158.2	1.0	3.0	3.0	3.0	1.0	2.0	2.0	1.0	1.0
RRIS2003	3.0	1.0	1.0	1.0	1.0	1.0	80.2	2.0	3.0	27.1	1.0	2.0	52.3	1.2	2.0	2.0	1.0	1.0	1.0	164.9	2.0	1.0	3.0	3.0	1.0	1.0	1.0	2.0	1.0
RRISL 226	3.0	1.0	1.0	4.0	1.0	1.0	73.6	2.0	1.0	25.3	1.0	3.0	55.6	1.4	1.0	2.0	2.0	1.0	1.0	150.2	1.0	1.0	2.0	1.0	2.0	4.0	3.0	2.0	1.0
PB28/59	3.0	1.0	1.0	3.0	2.0	2.0	93.6	2.0	4.0	32.7	1.0	2.0	56.2	2.5	2.0	2.0	2.0	2.0	2.0	133.6	1.0	3.0	2.0	3.0	1.0	2.0	1.0	2.0	1.0
PB86	3.0	2.0	1.0	1.0	1.0	3.0	89.0	1.0	4.0	31.4	2.0	2.0	30.6	1.4	2.0	2.0	2.0	1.0	3.0	141.9	1.0	3.0	3.0	2.0	1.0	1.0	1.0	1.0	1.0

1 - Axillary bud,
2 - Leaf scar
3 – Shape of leaf scar
4 - Shape of leaf storey
5 -Separation of leaf storey
6 - Ext. appearance of leaf storey
7 - Size and width of leaf storey
8 – Pulvinus
9 - Petiole shape
10 - Petiole size
11 – Petiole orientation
12 – Petiolue orientation
13 – Petiolule angle
14 – Petiolule size
15 – Petiolule junction appearance
16 – Leaflet colour
17 – Leaflet luster
18 – Leaflet texture
19 – Leaflet shape
20 – Leaf area
21 – Leaflet thickness
22 – Leaf margin
23 – Degree of leaflet separation
24 – Cross sectional appearance
25 – Longitudinal sectional appearance
26 – Shape of leaf apex
27 – Shape of leaf base
28 – Colour of veins
29 – Nature of veins