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JUVENILE CHARACTERS AND SEED MORPHOLOGY OF CERTAIN MODERN *HEVEA* CLONES

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Nine modern clones of *Hevea brasiliensis* were morphologically characterised at the age of 14 months, planted in the field at a spacing of 6.7 x 3.4 m. Morphological parameters studied were nature of buds and leaf scars, shape of leaf storey and characteristics of petioles, petiolules and leaflets. The observations were confirmed with nursery plants (60 x 60 cm spacing) of the same age. Seed morphology was also used to identify the clonal trees. Clones vary in respect of the different characters studied. A combination of different characters has to be taken into consideration for the identification of clones at young age.

Key words:- Hevea brasiliensis, Juvenile characters, Morphological parameters, Seed characters, Clone identification.

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INTRODUCTION

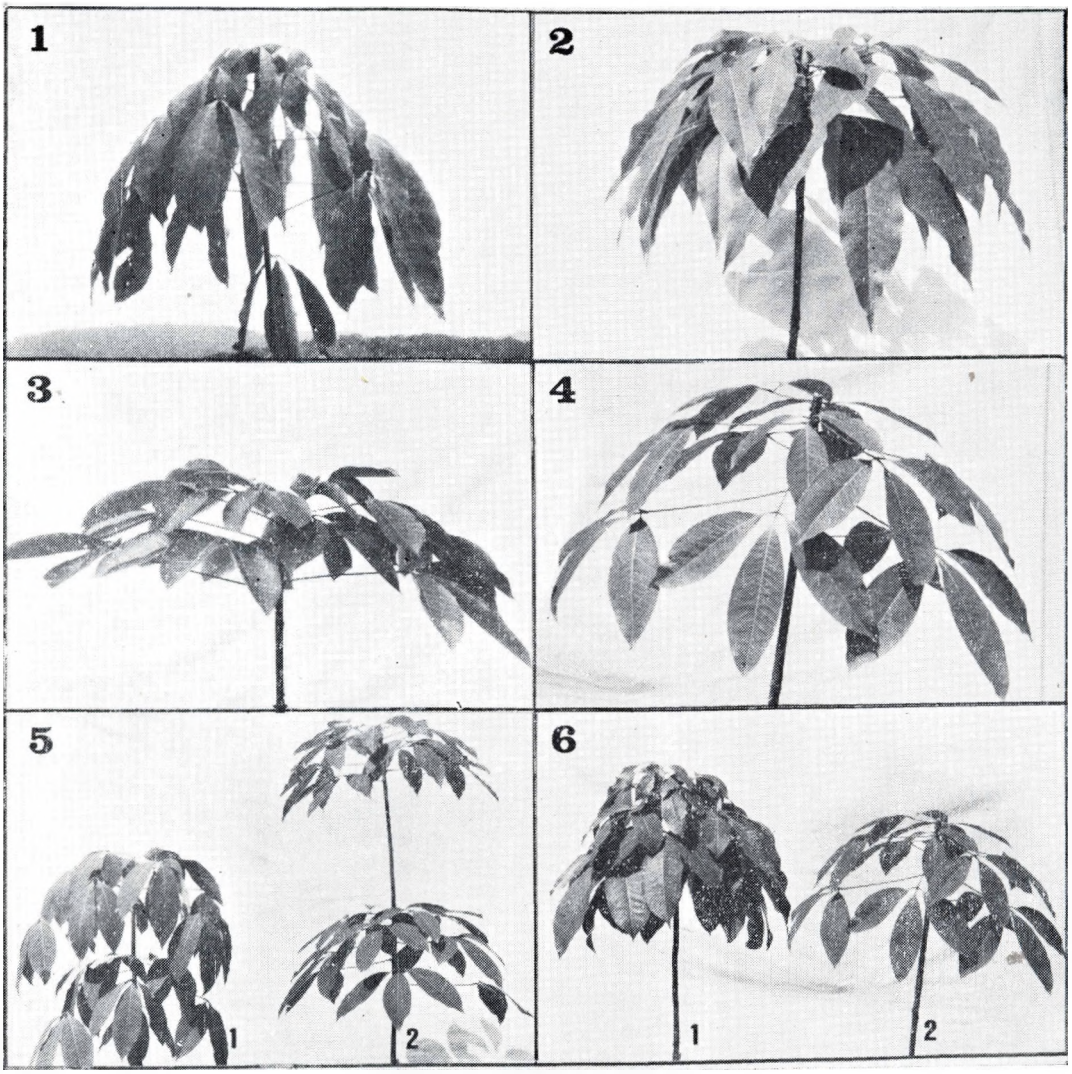
Clones of *Hevea brasiliensis* (Willd. ex. Adr. de Juss) Muell. Arg. in general do not exhibit highly conspicuous and very distinct variations in morphological characters. Knowledge of relatively consistent characteristics of a clone will enable planters to identify different clones recommended for planting. It will help them to make sure that the right clones are procured and used for planting. However, only little effort has been made to study in detail the morphology of different *Hevea* clones (Dijkman, 1951; Polhamus, 1962; Silva and Satchuthananthavale, 1961 and Jayasekara *et al.*, 1984). In the present investigation, an attempt is made to characterise nine modern clones of *Hevea brasiliensis* at their juvenile stage. Seed morphological characters which are useful in clone identification are also discussed.

MATERIALS AND METHODS

The study was carried out with nine clones (Table 1) of promising yield potential. Budded stumps of these clones were planted in polybags. The plants raised in the bags were transplanted to the field, at nine months' growth, during the 1989 planting season. The trial was laid out at the Experiment Station (Kottayam) of the Rubber Research Institute of India in a randomized block design. The spacing adopted was 6.7 x 3.4 m. For each of the clones, characters were recorded from fifteen plants, five each randomly selected from three replications, when the plants were at an age of 14 months. For the description of axillary buds, leaf storey and leaves, the topmost mature flush was used. Leaf scar was studied from the nodes just after leaf shedding. The terminologies suggested by Dijkman (1951), Jayasekera *et al.* (1984) and Lawrence (1967) have been used. Five fully expanded leaves, one each from different plants of each clone were used for quantifying length of petiole and petiolule, angle of insertion of petiolules and leaf area. All the three leaflets of each leaf were measured using a leaf area meter. Data on quantitative characters were subjected to statistical analysis.

Table 1. **Materials**

Clone			Parentage		
RRII 5	:	Primary clone	RRII 300	:	Tjir 1 x PR 107
RRII 105	:	Tjir 1 x Gl 1	RRII 308	:	PB 5/60 x Gl 1
RRII 118	:	Mil 3/2 x Hil 28	RRIM 600	:	Tjir 1 x PB 86
RRII 203	:	PB 86 x Mil 3/2	RRIM 703	:	RRIM 600 x RRIM 500
RRII 208	:	Mil 3/2 x AVROS 255			



Figs.1–4 Shape of leaf storey: 1 Conical 2 Truncate 3 Bow - shaped 4 Hemispherical
Fig. 5 Separation of leaf storey 5.1 Not well separated 5.2 Well separated
Fig. 6 External appearance of leaf storey 6.1 Close 6.2 Open

Young buddings were described according to the morphological characteristics adopting the following classification:

1. **Nodes**

1.1. **Axillary bud** : 1.1.1. sunken
1.1.2. more or less protruded

1.2. **Leaf scar** : 1.2.1. normal
1.2.2. with pronounced margins

2. **Leaf storey**

2.1. **Shape of leaf storey** (Figs. 1–4) 2.1.1. conical
2.1.2. truncate
2.1.3. bow-shaped
2.1.4. hemispherical

2.2. **Separation of leaf storey** (Fig. 5) : 2.2.1. not well separated
2.2.2. well separated

2.3. **External appearance of leaf storey** (Fig. 6) : 2.3.1. close (internodes close and leaves crowded)
2.3.2. open (internodes not close or crowded permitting more light penetration)
2.3.3. intermediate

3. **Leaves**

3.1. **Pulvinus** : 3.1.1. normal
3.1.2. swollen

3.2. **Petiole**

3.2.1. Shape (Fig. 7) : 3.2.1.1. arched
3.2.1.2. straight
3.2.1.3. concave
3.2.1.4. 'S' shaped

3.2.2. Size : 3.2.2.1. long
3.2.2.2. medium
3.2.2.3. short

3.3. **Petiolule**

3.3.1. Orientation (Fig. 8) : 3.3.1.1. upward
3.3.1.2. horizontal
3.3.1.3. downward

3.3.2. Angle : 3.3.2.1. narrow
3.3.2.2. wide

3.3.3. Size : 3.3.3.1. long
3.3.3.2. medium
3.3.3.3. short

3.4. **Leaflets**

3.4.1. Colour : 3.4.1.1. dark green
3.4.1.2. light green
3.4.1.3. yellowish green

3.4.2. Lusture : 3.4.1.1. dull
3.4.1.2. glossy

3.4.3. Texture : 3.4.3.1. leathery
3.4.3.2. smooth

3.4.4. Shape (Fig. 9) : 3.4.4.1. elliptical
3.4.4.2. obovate
3.4.4.3. diamond shaped elliptical

3.4.5. Size : 3.4.5.1. large
3.4.5.2. medium
3.4.5.3. small

3.4.6. Thickness : 3.4.6.1. thick
3.4.6.2. thin

3.4.7. Leaf margin : 3.4.7.1. smooth
3.4.7.2. wavy

3.4.8. Degree of separation : 3.4.8.1. overlapping
3.4.8.2. touching
3.4.8.3. well separated

3.4.9. Cross sectional appearance (Fig. 11) : 3.4.9.1. 'V' shaped
3.4.9.2. flat
3.4.9.3. boat shaped
3.4.9.4. convex

3.4.10. Longitudinal sectional appearance (Fig. 12) : 3.4.10.1. flat
3.4.10.2. convex
3.4.10.3. 'S' shaped

3.4.11. Leaf apex (Fig. 13) : 3.4.11.1. aristate
3.4.11.2. acuminate
3.4.11.3. cuspidate
3.4.11.4. apiculate

3.4.12. Colour of vein : 3.4.12.1. yellow
3.4.12.2. light green

3.4.13. Nature of vein : 3.4.13.1. prominent
3.4.13.2. not prominent

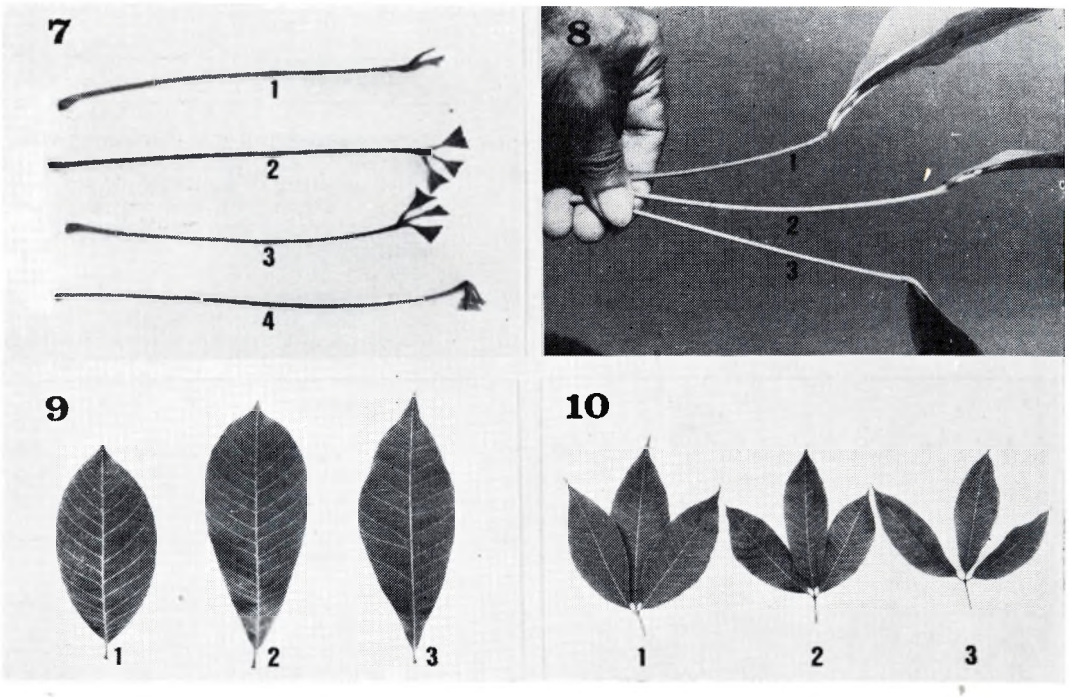


Fig. 7 Shape of petiole 7.1 Arched 7.2 Straight 7.3 Concave 7.4 'S' Shaped
Fig. 8 Orientation of petiolule 8.1 Upward 8.2 Horizontal 8.3 Downward
Fig. 9 Shape of leaflets 9.1 Elliptical 9.2 Obovate 9.3 Diamond-shaped elliptical
Fig. 10 Degree of separation of leaflets 10.1 Overlapping 10.2 Touching 10.3 Well separated

The observations were confirmed with five plants of each clone in the budwood nursery raised at a spacing of 60 x 60 cm and planted with polybag plants of the same age during the same planting season.

4. **Seed characters**

Seed size was determined by measuring the length, width and thickness and recording volume by water replacement. Seed size and morphology (Fig. 14) were recorded in 15 seeds sampled at random from mature bud-grafted plants of the respective clones. The characters recorded were:

4.1. **General size, shape and appearance**

4.2. **Dorsal side – shape**

4.3. **Ventral side – shape**

4.4. **Seed coat markings**

RESULTS AND DISCUSSION

The nine clones studied exhibit differences in plant morphology as well as seed morphology. These promising clones are described as depicted in Figs. 1–14 and Tables 2–5. Individual plants within a clone were in general similar and comparable with respect to the characters studied. Individual plants of a clone which originate from one parent tree, are remarkably alike in appearance when grown in a uniform environment (Silva and Satchuthananthavale, 1961).

Buds and leaf scars were more prominent in RRII 5, RRII 118 and RRIM 703 in comparison to other clones. Dijkman (1951) and Polhamus (1962) also reported the importance of bud and leaf scar in identifying different clones.

Table 2. **Morphological characters of young budgrafts at an age of 14 months**

Clone	Nodes	Leaf storey	Leaves
RRII 5	Buds prominent; leaf scar prominent	Conical; separated; closed	Petiole arched; petiolule downward; leaflets light green, dull, thin, obovate; margin wavy; longitudinal section 's' shaped; cross section convex; leaf apex asymmetrically cuspidate; leaflets overlapping; vein prominent, pale yellow.
RRII 105	Buds normal; leaf scar prominent	Bow shaped; well separated; open	Petiole straight; petiolule horizontal; leaflets dark green, glossy, thick, diamond shaped elliptical; margin smooth; longitudinal section and cross section flat; leaf apex acuminate; leaflets separated; vein prominent, pale green.
RRII 118	Buds prominent; leaf scar prominent	Hemispherical; well separated; closed	Petiole straight; petiolule horizontal; leaflets light green, dull, thin, elliptical; margin wavy; longitudinal section flat; cross section boat shaped; leaf apex apiculate; leaflets overlapping; vein not prominent, pale green; pulvinus prominent.
RRII 203	Buds normal; leaf scar normal	Hemispherical; not well separated; closed	Petiole straight; petiolule downward;leaflets green, dull, thick, elliptical; margin smooth; longitudinal section and cross section flat; leaf apex aristate; leaflets separated; vein not prominent, pale green.
RRII 208	Buds normal; leaf scar normal	Truncate; not well separated; closed	Petiole straight; petiolule horizontal; leaflets light green, dull, thick, elliptical; margin slightly wavy; longitudinal section flat; cross section boat shaped; leaf apex apiculate; leaflets separated; vein not prominent, pale green.
RRII 300	Buds prominent; leaf scar normal	Truncate; not well separated; intermediate between open and closed	Petiole straight; petiolule horizontal; leaflets dark green, dull, thick, diamond shaped elliptical; margin smooth; longitudinal section flat; cross section slightly boat shaped; leaf apex aristate; leaflets separated; vein prominent, pale yellow.
RRII 308	Buds normal; leaf scar normal	Hemispherical; separated,; intermediate between open and closed	Petiole straight; petiolule horizontal; leaflets light green, dull, thick, elliptical; margin smooth; longitudinal section and cross section flat; leaf apex aristate; leaflets touching; vein less prominent, yellow.
RRIM 600	Buds normal; leaf scar normal	Conical; not well separated; open	Petiole 'S' shaped; petiolule upward; leaflets yellowish green, semi glossy, thick, elliptical; margin smooth; longitudinal section arched; cross section slightly concave; leaf apex apiculate; leaflets separated; vein prominent, yellow.
RRIM 703	Buds prominent; leaf scar prominent	Hemispherical, well separated; closed	Petiole slightly arched; petiolule downward; leaflets yellowish green, dull, very thick, elliptical; margin smooth; longitudinal section arched; cross section flat; leaf apex aristate; leaflets touching; vein very prominent, yellow; pulvinus very prominent.

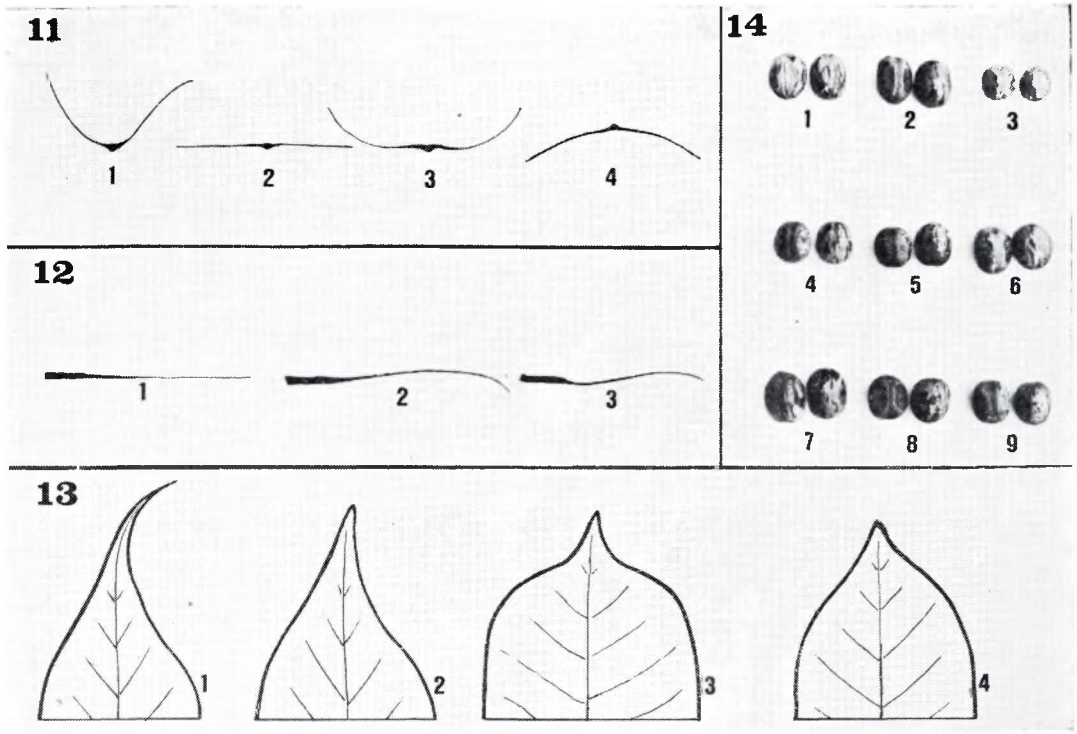


Fig. 11 Cross sectional appearance of leaflets 11.1 'V' Shaped 11.2 Flat 11.3 Boat shaped 11.4 Convex
Fig. 12 Long sectional appearance of leaflets 12.1 Flat 12.2 Convex 12.3 'S' Shaped
Fig. 13 Leaf apex 13.1 Aristate 13.2 Acuminate 13.3 Cuspidate 13.4 Apiculate
Fig. 14 Seed morphology. Ventral side (left); Dorsal side (right). 14.1 RRII 5 14.2 RRII 105 14.3 RRII 118 14.4 RRII 203 14.5 RRII 208 14.6 RRII 300 14.7 RRII 308 14.8 RRIM 600 14.9 RRIM 703

The leaf storey, specifically the uppermost mature one as reported by Silva and Satchuthananthavale (1961) provides several valuable diagnostic characters. The composite shape of leaf storey viz., hemisphere, bow-shaped, conical and truncate was observed to be genotype specific. The leaf storey of RRII 5 and RRIM 600 was conical in shape RRII 300 and RRII 208 had truncate storey and RRII 105 bow-shaped. In all the other clones observed, leaf storey was hemispherical in shape.

There were marked variations in size of petiole, petiolule and leaflets (Table 3). Clones differed significantly in petiole length, petiolule length and leaflet area. Petiole and petiolule length were maximum in clone RRII 5 (24.70 cm and 2.42 cm respectively) and minimum in RRII 308 (16.90 cm and 0.51 cm respectively). Leaflet area was numerically high in RRII 5 (485.21 cm^2) and RRII 203 (371.14 cm^2). Increased leaf area may result in increased photosynthetic rate and thereby high vigour.

The important distinguishing characters of the leaflets are colour, lusture, texture, size, shape, leaf margin, longitudinal section, cross section, leaf apex and degree of separation. Leaflets of RRII 105 are very glossy and dark green – a distinct distinguishing character of the clone. The leaflets of RRII 105 and RRII 300 are diamond shaped ellip-

Table 3. **Mean±, S.E. and C.D. of certain morphological traits at an age of 14 months**

Clone	Petiole length (cm)	Petiolule length (cm)	Angle of petiolule (°)	Leaflet area (cm²)
RRII 5	24.70 ± 2.473	2.42 ± 0.161	20.50 ± 0.608	485.21 ± 48.542
RRII 105	20.40 ± 0.533	1.21 ± 0.107	19.80 ± 0.751	341.19 ± 27.952
RRII 118	22.02 ± 2.021	1.01 ± 0.098	18.41 ± 0.885	353.29 ± 31.869
RRII 203	23.70 ± 1.598	1.07 ± 0.129	21.72 ± 1.373	371.14 ± 27.732
RRII 208	19.64 ± 0.961	0.63 ± 0.081	17.19 ± 0.514	216.56 ± 16.865
RRII 300	17.72 ± 0.881	1.54 ± 0.072	20.70 ± 0.783	313.41 ± 18.676
RRII 308	16.90 ± 1.355	0.51 ± 0.044	16.68 ± 1.229	304.78 ± 28.698
RRIM 600	21.56 ± 1.417	1.06 ± 0.080	17.21 ± 1.122	214.20 ± 29.629
RRIM 703	22.06 ± 1.310	1.12 ± 0.197	18.00 ± 0.935	299.08 ± 36.489
C.D.	4.258	1.19	N.S.	90.197

Table 4. **Seed size**

Clone	Mean length (cm)	Mean width (cm)	Mean thickness (cm)	Volume (cm³)
RRII 5	2.77 ±0.071	2.19 ±0.054	2.15 ±0.040	8.00 ±0.632
RRII 105	2.73 ±0.042	2.12 ±0.029	1.95 ±0.022	5.70 ±0.153
RRII 118	2.31 ±0.087	2.05 ±0.224	1.88 ±0.034	4.17 ±0.307
RRII 203	2.48 ±0.017	2.10 ±0.036	1.79 ±0.027	5.16 ±0.166
RRII 208	2.26 ±0.034	1.92 ±0.025	2.00 ±0.013	5.75 ±0.250
RRII 300	2.76 ±0.037	2.27 ±0.037	2.02 ±0.019	6.20 ±0.199
RRII 308	2.81 ±0.046	2.14 ±0.030	1.96 ±0.037	7.81 ±0.133
RRIM 600	2.60 ±0.021	2.32 ±0.025	1.66 ±0.022	5.52 ±0.167
RRIM 703	2.47 ±0.029	2.10 ±0.020	1.87 ±0.030	5.28 ±0.096

Table 5. **Seed morphology**

Clone	Size, shape & appearance, seed coat markings	Dorsal side	Ventral side
RRII 5	Large, Almost oval and shiny, Dark brown patches well distributed	Prominent central ridge. Lateral depression not prominent.	Frontal depression and lateral cheeks are prominent
RRII 105	Medium, Oblong and shiny, Dark brown patches and brown mottlings	No central ridge. Lateral depression present	Lateral cheeks and frontal depression prominent
RRII 118	Small, Round and dull, Seed coat greyish brown with light brown patches	No central ridge. Lateral depression present.	Lateral cheeks faintly developed, frontal depression not prominent
RRII 203	Small, Round and dull, Seed coat greyish brown with brown patches and mottlings	No central ridge. Lateral depression not prominent	No frontal depression. Lateral cheeks faintly developed
RRII 208	Small, Round and shiny, Brown markings are very prominent at micropylar end	No central ridge. Lateral depression present	No frontal depression. Lateral cheeks faintly developed
RRII 300	Medium, Oblong and shiny, Darkbrown patches well distributed over the dorsal side. Mottlings prominent towards micropylar end	Slightly develoed central ridge. Lateral depression not prominent.	No frontal depression. Lateral cheeks faintly developed
RRII 308	Large, Oblong and shiny, Prominent brown with dark brown patches in the micropylar region	No central ridge. Lateral depression present on dorsal side.	Frontal depression and lateral cheeks are prominent
RRIM 600	Medium, Squarish and nearly flat, Seed coat greyishbrown with dark brown patches well scattered over the dorsal side. mottlings prominent at the Micropylar end	No central ridge and no lateral depression.	Frontal depression and large lateral cheeks are well developed
RRIM 703	Medium, Slightly elongated, Dark brown patches and mottlings well distributed over the dorsal side	No central ridge. Lateral depression not prominent.	Faintly developed. Lateral cheeks. No frontal depression

tical and that of RRII 5 obovate, while in all others the leaflet was elliptical in shape. Leaf apex was predominantly of the aristate type.

Seed characteristics

Mature seeds from trees of any one clone are consistently uniform in the external characters of the seed coat which is derived from the tissues of the mother tree and is independent of the male parent (Silva and Satchuthananthavale, 1961; George *et al.*, 1980). The morphology of seeds of the different clones showed variations (Fig. 14 and Tables 4 and 5). The seeds of RRII 5 recorded the highest volume (8.00 cm^3) in contrast to the lowest value in RRII 118 (4.17 cm^3), the seeds of which was only half the size of the former. Clone RRII 5 also recorded highest seed thickness (2.12 cm) whereas the lowest value was noted in RRIM 600 (1.66 cm). However, seed length did not show much variation between clones; the highest mean value was 2.81 cm in RRII 308 and lowest was 2.26 cm in RRII 208. Mean width ranged from 2.32 cm (RRIM 600) to 1.92 cm (RRII 203). In the present study, within clone variability in seed morphology was relatively low. At maturity, seed of a single mother tree or clone exhibits the same colour, markings and shape which can be used to identify the mother tree with reasonable accuracy (Sprecher, 1951; Silva and Satchuthananthavale, 1961; Saraswathy Amma *et al.*, 1981; Jayasekera *et al.*, 1984 and Rubber Research Institute of Malaysia, 1990).

Fourteen months old young unbranched budgrafts of clones exhibited stable clonal characters. Dijkman (1951), Silva and Satchuthananthavale (1961); Polhamus (1962) and Jayasekera *et al.* (1984) also reported that an age of 12–18 months is the most favourable period for clone identification. Appearance of nodes, leaf storey and leaves were specific to each clone and found to be more or less stable.

Identification of the mature budded trees based on vegetative characters is rather difficult (Silva and Satchuthananthavale (1961) and Jayasekera *et al.* (1984). However, some of these characters could be used for identification of clones at mature stage along with other mature horticultural characters such as nature of stem, branching habit and characteristics of crown.

The present investigation indicate that the appearance, shape and size of seeds showed marked clonal differences. The differences in colour and markings of seed coat were also of diagnostic importance. In order to identify different clones authentically at young age, a combination of different juvenile characters need to be considered. From the key which can be derived from the description of clones (Table 2) it may be noted that a single character cannot be relied upon for identification of a clonal population. This is naturally expected as the identification is at subspecific levels and therefore as many relatively constant characters as practicable may be taken into consideration.

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