Natural Rubber Research, **25**(1): 31-38, 2012

FURTHER EVALUATION AND SELECTION OF 1981 IRRDB WILD *HEVEA* GERMPLASM COLLECTION IN INDIA

C.P. Reghu, M.A. Mercy and Radha Lakshmanan

Rubber Research Institute of India, Kottayam – 686 009, Kerala, India

Received : 26 May 2011 Accepted : 3 December 2011

Reghu, C.P., Mercy, M.A. and Lakshmanan, R. (2012). Further evaluation and selection of 1981 IRRDB wild *Hevea* germplasm collection in India. *Natural Rubber Research*, **25**(1): 31-38.

A mature phase evaluation of selected wild accessions of *Hevea brasiliensis* from the 1981 IRRDB Brazilian wild germplasm collection established at the Rubber Research Institute of India was done on the basis of various agro-morphological traits such as growth, yield, bark anatomical characters and timber potential. These wild accessions represent three provenances of Brazil, *viz*. Acre, Rondonia, and Mato Grosso. Field experiments were conducted at the Regional Research Station of Rubber Research Institute of India at Padiyoor, in Northern Kerala. The popular clone, RRII 105 was used as control.

The accessions showed significant variability for all the characters. In the year of opening, six out of eighty accessions were found superior to RRII 105 for girth and this trend continued for the subsequent five years under regular tapping. The accession MT 2233 was significantly superior to RRII 105 in bark thickness. Two Acre accessions (AC 635 and AC 166) had significantly higher number of latex vessel rows than that of RRII 105 and the number of latex vessel rows was on par with the control in 44 accessions. One Rondonian accession (RO 368) showed significant superiority for density of laticifers over RRII 105 and 11 accessions comprising two from Acre and nine from Mato Grosso provenances were on par with that of the check clone. Thirty three accessions had latex vessel diameter on par with that of RRII 105, indicating the scope for selection in the wild accessions for yield-related anatomical traits. Increased number of laticifer rows found in an accession might have contributed its high yield potential.

Six accessions had significantly higher bole volume than that of RRII 105. Among these, two accessions with low dry rubber yield can be considered as potential timber yielding accessions and the remaining four accessions with high timber yield and comparatively medium latex yield can be considered for developing timber-latex clones. The wild accession AC 166, gave good yield and this was reconfirmed in further on-farm evaluation. The possibility of using the inherent genetic variability available in this wild population for future crop improvement programmes is discussed.

Keywords: Bark anatomy, Brazilian germplasm, Dry rubber yield, *Hevea brasiliensis*, Timber yield, Wild accession

INTRODUCTION

Considering the need for broadening the existing narrow genetic base of natural rubber, *Hevea brasiliensis*, a joint effort in building up of fresh germplasm collection representing the centre of diversity in Brazil

Correspondence: Reghu, C.P. (Email: reghu@rubberboard.org.in)

was made by the International Rubber Research and Development Board (IRRDB) and EMBRAPA during 1981(Allen,1984). Accordingly, an expedition team collected 64,736 seeds and 194 ortets from three states of Brazil, *viz.* Acre, Rondonia and Mato Grosso, covering 64 locations within 16 districts (IRRDB, 1982). These collections were established in three base centers in Brazil, Ivory Coast (Cote de Ivoire) and Malaysia for further multiplication and redistribution to all IRRDB member countries.

From this collection, 4538 accessions were introduced to India during the period 1984 to 1990 in batches and they are being conserved *ex situ* in the traditional region in Kerala and the non-traditional region of the North East India. All these wild accessions are being subjected to nursery evaluation, preliminary evaluation and further evaluation and selection.

The first further evaluation trial was planted during 1995 using 80 promising wild accessions selected based on the preliminary evaluation results of 200 wild accessions. The performance of these accessions with respect to growth, yield and bark anatomical traits at the age of seven years (early mature phase) was analysed and published earlier (Reghu *et al*., 2004). The present paper reports the results of field evaluation of these wild accessions at the mature phase on the basis of various agro-morphological traits such as growth, yield, bark anatomical characters and timber potential.

MATERIALS AND METHODS

The material consisted of 80 wild accessions selected on the basis of preliminary evaluation. These included accessions from the three provenances of Brazil *viz.* Acre (22 accessions), Rondonia (20 accessions) and Mato Grosso (38 accessions). The field experiment was conducted at the Regional Research Station of the Rubber Research Institute of India at Padiyoor, in Northern Kerala situated at 75° 36′ E and 11° 58′ N. The annual rainfall of the station was 3500 - 4000 mm. The statistical design adopted was simple lattice with four replications and with a plot size of four plants at a spacing of 6.7 x 3.4 m. The popular clone, RRII 105 was used as control.

The characters studied were:

(a) Girth of the tree at 150 cm height from the bud union for six years (2004-2009)

(b) Bark thickness (mm) at the time of opening the tree for regular tapping (2004)

(c) Total number of laticifer rows (TLVR) at the time of opening the tree for regular tapping

(d) Density of laticifers per row per mm circumference of the plant (DLV)

(e) Mean dry rubber yield (g/t/t) for two years (2007 - 2008)

(f) Mean summer season dry rubber yield (g/t/t) for two years (2007 - 2008)

(g) Mean peak season dry rubber yield (g/t/t) for two years (2007 - 2008)

(h) Clear bole volume (m^3) at the age of 13 years

Bark samples were collected from tapping height and fixed in FAA for anatomical investigations. Prior to fixing, the thickness of sampled bark was measured.

Sections at cross sectional (CS), tangential longitudinal (TLS) and radial longitudinal (RLS) planes were cut at 30 µ thickness using a sledge microtome (Leica SM 2000 R). The sections were stained with Oil Red 'O' (Philipose and Reghu, 2003), microslides were prepared and observed under Wild Leitz Aristoplan microscope attached to image analysis software (Leica Q 500 W, Cambridge, England).

The experimental trees were opened for regular tapping during 2004 (at the age of nine years) at S2/d3 system and dry rubber yield was collected at fortnightly intervals. The mean annual yield was recorded continuously for a period of five years (2004-2008). In addition to this, summer and peak season yields were also calculated separately during the last two years (2007 -2008).

The timber (clear bole) volume was estimated at the age of 14 years using the quarter girth method (Chaturvedi and Khanna, 1982) and formula,

$$V = (G/4)^2 \times L$$

where, V= bole volume (m^{3-}),
G= girth (m) , L= bole height (m).

Analysis of variance for the different traits was carried out (Panse and Sukhatme, 1985) and significance was tested (Fisher and Yates, 1963).

RESULTS AND DISCUSSION

Growth performance

The trees were opened for regular tapping during 2004 (at the age of 9 years) and the annual girthing pattern and monthly dry rubber yield for the subsequent five years till 2008 were recorded. The summer season yield, peak season yield and total yield were computed separately for the last two years (2007-2008).

At opening for tapping, out of the total 80 accessions evaluated, six were superior in girth to RRII 105 and this trend continued for the subsequent four years of regular tapping (Table 1). Five years after initiation of tapping, the accession MT 1032 (74.9 cm) ranked top for girth followed by MT 941 (72.8 cm), MT 1674 (72.3 cm) and RO 2385 (72.2 cm). These accessions are expected to have good potential for timber. Sixty one accessions had girth statistically on par with RRII 105, of which 13 accessions were from

Table 1. **Wild accessions showing better growth than RRII 105**

Accessions	Girth (cm)				
	2004 (9^{th} year)	2005 (10^{th} year)	2006 (11^{th} year)	2007 (12^{th} year)	2008 (13^{th} year)
MT 1674	53.8	58.7	62.9	68.2	72.3
MT 941	52.7	58.4	61.7	68.6	72.8
MT 1032	52.3	57.9	61.4	72.0	74.9
MT 999	52.1	57.8	60.1	65.9	68.9
MT 1640	51.8	57.2	59.3	64.9	68.8
RO 2385	51.5	57.0	59.2	69.1	72.2
RRII 105	42.6	48.9	49.2	56.9	59.0
CD (P=0.05)	8.3	8.3	10.0	7.9	9.7

Acre, 14 from Rondonia and 36 from Mato Grosso. Considerable genetic variation among the accessions from Acre, Rondonia and Mato Grosso has been reported by Varghese *et al.* (2002). Thus the inherent genetic variability in this population will aid selection programmes and enable the breeder to apply enough selection pressure for desirable characters.

Bark structural traits

Table 2 shows the potential accessions superior to RRII 105 for bark structural traits *viz*. bark thickness, total number of latex vessel rows, density of laticifers and diameter of laticifers at the age of opening. The bark thickness of the wild accessions ranged from 3.82 mm (AC 651) to 6.87 mm (MT 2233) whereas it was 5.68 mm. for the check clone RRII 105. The analysis of variance indicated that one Mato Grosso accession (MT 2233) had bark thickness significantly superior to RRII 105. Fifty eight accessions comprising 13 from Acre, 13 from Rondonia and 32 from Mato Grosso had bark thickness statistically on par with that of the check clone.

The total number of latex vessel rows was minimum for MT 191 (4.00) and maximum for AC 635 (9.75) whereas the check clone RRII 105 had a mean number of 7.00 latex vessel rows. Analysis of variance revealed that two Acre accessions (AC 635 and AC 166) had significantly higher number of latex vessel rows than RRII 105 and in 44 accessions (Acre- 5; Rondonia- 9; Mato Grosso-30), the number of latex vessel rows was statistically on par with the control. In wild germplsm, Madhavan *et al*. (1996) have reported high correlation between number of latex vessel rows and yield and hence, the accessions with maximum number of latex vessel rows hold importance in crop breeding programmes aimed at yield improvement.

The density of laticifers per row per mm circumference of the tree was minimum for AC 761 (22.67) and maximum for RO 368 (35.67) among the wild accessions whereas it was 32.27 in RRII 105. One Rondonian accession (RO 368) showed significant superiority for this trait over RRII 105 and 11 accessions comprising two from Acre and nine from Mato Grosso provenances were statistically on par with that of the control.

The diameter of laticifers was minimum for MT 199 (17.71μ) and maximum for the accession MT 919 (29.28 μ), which was significantly superior to that of RRII 105 (25.78 μ). Thirty three accessions comprising 10 Acre, 8 Rondonia and 15 Mato Grosso had the diameter statistically on par with that of RRII 105. Significant genotypic differences among wild germplasm accessions for

Table 2. **Accessions superior to RRII 105 for structural traits**

Trait	Bark thickness (mm)	No. of laticifers rows	Density of laticifers (Per row/mm)	Diameter of laticifers (μ)
Superior	6. 87	9.75 (AC 635)	35.67	29.28
accessions	(MT 2233)	9.25 (AC 166)	(RO 368)	(MT 919)
Control (RRII 105)	5.68	7.00	32.27	25.78
CD (P=0.05)	1.13	1.74	3.32	2.61

Table 3. **Accessions showing better performance for mean dry rubber yield**

Accessions	Summer season yield (g/t/t)		Peak season yield (g/t/t)		Total yield (g/t/t)		Percentage yield over RRII 105	
	4th year	5th year	4th year	5th year	4th year	5th year	4th year	5th year
AC 166	31.64	46.03	57.06	66.32	49.40	56.08	108.00	91.20
MT 1020	27.96	18.00	50.97	36.55	48.68	26.97	106.00	43.00
MT 179	20.37	14.37	49.78	32.61	45.35	23.57	99.00	38.00
RO 2908	25.96	16.48	56.99	56.08	44.45	43.78	97.00	71.00
AC 675	20.55	13.89	49.88	35.93	43.44	26.09	94.80	42.00
RO 2385	21.81	15.24	49.01	40.11	41.12	32.57	89.80	52.80
AC 655	20.04	20.45	38.67	40.69	39.44	30.80	86.00	50.00
AC 2004	21.32	23.44	47.34	46.50	39.44	34.86	86.00	56.70
MT 54	22.40	15.49	41.04	30.73	35.35	20.37	77.00	33.00
AC 670	18.95	28.29	27.77	52.85	26.99	40.78	59.00	66.00
RRII 105	23.44	41.18	44.51	82.73	45.79	62.27		
CD (P=0.05)	9.10	10.91	19.44	19.74	13.23	14.78		

various bark structural characteristics have been reported (Reghu *et al.*, 1996) and the results obtained in this study are also in conformity with that report, indicating the scope for selection in the wild accessions for these yield-related anatomical traits.

Dry rubber yield

Of the 80 wild accessions, 14 accessions had summer and peak season yield statistically on par with that of RRII 105 in the fourth year, whereas only one accession (AC 166) was statistically on par with the check clone during the fifth year of tapping. With respect to total yield, 10 accessions had yield statistically on par with that of RRII 105 during the fourth year of tapping and only one accession (AC 166) was statistically on par with the check clone during the fifth year (Table 3). Though the wild accessions were generally poor yielders, the yield trend in accession AC 166 was good during summer and peak yielding seasons (Fig.1), indicating the superiority of this accession among the 80 wild germplasm accessions selected for the study. The high number of laticifer rows found in this accession might have contributed towards its yield. Only two accessions, AC 166 and AC 670, showed an increasing trend in yield pattern from the fourth to the fifth year of tapping. Similar genotypic difference for test tap yield among the same set of accessions in the juvenile stage evaluation has been reported by Reghu *et al*. (2004).

The yield as percentage of that of the check clone RRII 105 was also worked out among the superior wild accessions, in order to compare the potential of these accessions. Eight accessions showed more than 80 percentage (86% - 108%) of the yield of RRII 105 with respect to total yield after the fourth year of tapping, whereas in the fifth year of tapping, only one accession (AC 166) had

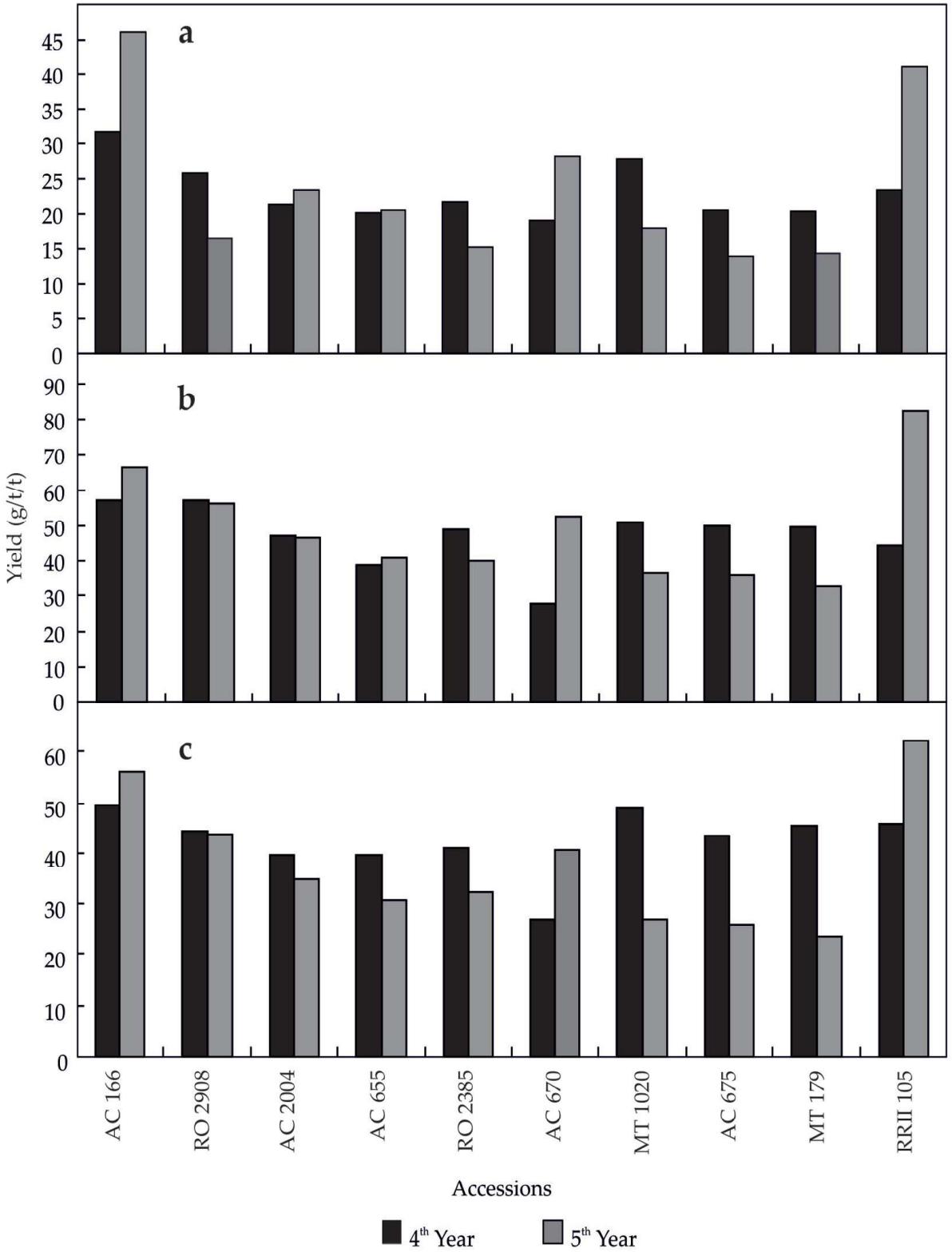

Fig. 1. Yield performance of top 10 accessions and check clone RRII 105 in different seasons
a) Summer yield b) Peek yield c) Total yield

high yield (91.20 % of the yield of RRII 105). Though the scope for direct selection for yield is remote, identifying an accession with more than 90% yield of the high yielding clone RRII 105 from the untapped source (wild germplasm) is of great importance. Since the wild germplasm accessions represent an entirely different gene pool, utilization of these selected high yielding accessions in future breeding programmes is of great importance as there is scope for gene introgression between wild and domesticated *Hevea* clones enabling wider genetic base of *H. brasiliensis.*

Table 4. **Accessions showing potential for timber yield**

Accessions	Bole volume (m^3)	Dry rubber yield (g/t/t)	% dry rubber yield over RRII 105
AC 661	0.151	4.4	7.0
MT 941	0.126	21.6	35.1
AC 650	0.126	20.7	33.6
MT 1674	0.124	14.6	23.8
MT 1032	0.124	16.4	26.7
AC 155	0.123	4.8	7.9
RRII 105	0.082	62.3	-
CD (P= 0.05)	0.040		

Volumetric timber yield

Rubber wood, a byproduct of rubber plantations has become an important raw material for various wood-based industries in major rubber growing countries. The wild germplasm accessions with vigorous growth are important in this respect, if they have good bole volume. The estimation of bole volume revealed that six accessions (three each from Acre and Mato Grosso) had significantly higher bole volume than that of RRII 105 (Table 4) and 59 accessions had the bole volume statistically on par with the control. Out of these six accessions, two accessions (AC 661 and AC 155) had very low dry rubber yield (7.0 – 7.9% of RRII 105) and these can be considered for potential timber yield alone. In the remaining four accessions with high timber yield, the percentage dry rubber yield compared with that of RRII 105 was 23.8 - 35.1% indicating a scope for utilizing them in crop improvement programmes for developing timber-latex clones.

Analysis of data from the various field trials and preliminary observations from the nurseries have revealed variability among the wild *Hevea* germplasm accessions for most of the agro-morphological traits, bark structural characters and juvenile yield, indicating the scope for selection of accessions with desirable characters (Annamma *et al*., 1989; Abraham *et al*., 1992, 2000; Madhavan *et al*., 1993; Mercy *et al*., 1993, 1995; Rao *et al*., 1996; Reghu *et al*., 2004). Being the basic genetic material for the current crop improvement programme to meet the future demands of the natural rubber industry, wild germplasm of *H. brasiliensis* has great importance. Hence, the wide range of variation observed for various characters indicate the presence of inherent genetic variability in this population, which can be made use of in future crop improvement programmes. The merit of the wild accession AC 166, which gave good yield can be further assessed by incorporating it in on- farm evaluation trials.

ACKNOWLEDGEMENT

The help rendered by Sri. P. Aneesh, Statistical Inspector, RRII for data analysis is gratefully acknowledged.

REFERENCES

Abraham, S. T., Reghu, C.P., Madhavan, J., George, P.J., Potty, S.N., Panikkar, A.O.N. and Saraswathy, P. (1992). Evaluation of *Hevea* germplasm 1: Variability in early growth phase. *Indian Journal of Natural Rubber Research*, **5**(1&2): 195-198.

Abraham, S.T., Panikkar, A.O.N., George, P.J., Reghu, C.P. and Nair, R.B. (2000). Genetic evaluation of wild *Hevea* germplasm: Early performance. Paper presented in *XIV PLACROSYM-International Conference on Plantation Crops*, Hyderabad, 12-15 December, 2000.

Allen, P.W. (1984). Fresh germplasm for natural rubber. *Span*, **27**(1): 7-8.

Varghese, Y.A., Marattukalam, J.G., George, P.J. and Panikkar, A. O. N. (1989). Nursery evaluation of some exotic genotypes of *Hevea brasiliensis* Muell. Arg. *Journal of Plantation Crops*, **16** (Supplement): 335-342.

Chaturvedi and Khanna, (1982). Forest Mensuration. International Book Distributers, Dehradun. pp. 1-9.

Fisher, R.A. and Yates, F. (1963). *Statistical Tables for Biological, Agricultural and Medical Research.* Longman, England, 146 p.

IRRDB (1982). Status report of primary nursery. In: *The 1981 Germplasm Project: Reports from the three centers and on the meeting of Senior Plant Breeders*, (18th June 1982) Manaus, Brazil.

Madhavan, J., Reghu, C.P., Abraham, S.T., George, P.J. and Potty, S.N. (1993). Genetic resources of *Hevea.* Paper presented in the '*ISPGR Dialogue in Plant Genetic Resources: Developing national policy*', New Delhi, 1993.

Madhavan, J., Reghu, C.P., Abraham, S.T., George, P.J. and Potty, S.N. (1996). Evaluation of *Hevea* germplasm: VII. Association analysis in wild *Hevea* germplasm. *Journal of Plantation Crops*, **24**(Supplement): 453-457.

Mercy, M.A., Abraham, S.T., George, P.J., Potty, S.N., Sethuraj, M.R. and Saraswathi, P. (1993). Preliminary observations of the 1981 IRRDB *Hevea* germplasm. II. Variability, dry matter and morphological characters. *Journal of Plantation Crops,* **21**(Supplement): 268-274.

Mercy, M. A., Abraham, S.T., George, P.J. and Potty, S.N. (1995). Evaluation of *Hevea* germplasm: Observations on certain prominent traits in a conservatory. *Indian Journal of Plant Genetic Resources*, **8**(1): 35-39.

Panse, V.G. and Sukhatme, P.V. (1985). *Statistical Methods for Agricultural Workers.* Indian Council of Agricultural Research, New Delhi, pp. 45-149.

Philipose, O. and Reghu, C.P. (2003). Staining procedure for laticiferous system of *Hevea brasiliensis* using Oil Red O. *Indian Journal of Natural Rubber Research*, **16**(1&2)**:** 41-44.

Rao, G. P., Reghu, C.P. and George, P.J. (1996). Evaluation of *Hevea* germplasm VIII. Variability in certain juvenile characters of Wild *Hevea* germplasm. *Journal of Cytology and Genetics*, **34** (2): 183-186.

Reghu, C.P., Abraham, S.T., Madhavan, J., George, P.J., Potty, S.N. and Leelamma, K.P. (1996). Evaluation of *Hevea* germplasm: Variation in bark structure of wild Brazilian germplasm. *Indian Journal of Natural Rubber Research,* **9**(1): 28-31.

Reghu, C.P., Abraham, S.T., Nair, R.B. and Varghese, Y.A. (2004). Performance of certain wild *Hevea* accessions in the early phase of further evaluation. *Indian Journal of Natural Rubber Research,* **17**(2): 103-107.

Varghese, Y.A., Abraham, S.T., Mercy, M.A., Madhavan, J., Reghu, C.P., Rao, G.P., Ammal, S. L., Idicula, S. P. and Joseph, A. (2002). Management of the 1981 IRRDB germplasm collection in India. *IRRDB Joint Workshop on Plant Breeding, Agronomy and Socio-economics* (28 August - September 2002), Malaysia and Indonesia.