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PATH COEFFICIENT ANALYSIS OF YIELD AND YIELD ATTRIBUTES IN THE *HEVEA BRASILIENSIS* CLONE RRII 105

Interclonal variations are often very marked in a mature plantation of *Hevea brasiliensis* Muell. Arg. Apart from significant variations in yield and girth of the trees (Premakumari *et al.*, 1991; Varghese *et al.*, 1993), there are prominent differences in the shape and structure of the canopy, shape, size and orientation of leaflets etc. between clones. In addition to this, intraclonal variations in yield and certain growth characteristics are also observed though vegetative propagation through budgrafting guarantees the genetic homogeneity of the shoots (Dijkman, 1951; Buttery, 1961; Ng *et al.*, 1981; Chandrashekar *et al.*, 1993). It is generally suggested that one of the sources of intraclonal variations may be the heterogeneous root stocks which are grown from seeds produced largely through pollination between trees belonging either to the same or different clones (Yeang *et al.*, 1995; Sobhana, 1998). These seeds are heterozygous in nature (Dijkman, 1951). While root stock effects on scion performance are largely taken for granted, it remains to be scientifically proven that the genetic heterogeneity of the root stock is the cause of the large intraclonal variations that are observed in rubber plantations. The intraclonal variations are not only confined to growth, but to latex yield and flow characteristics also. Enzyme polymorphism was observed in young plants within a given clone budgrafted to polyclonal root stocks (Krishnakumar *et al.*, 1992). Intraclonal variations in isozyme profiles of three enzyme systems such as peroxidase, catalase and esterase were observed in the leaf and bark tissues of the scion indicating the possible influence of the rootstock on gene expression in the scion (Sobhana, 1998; Sobhana *et al.*, 2000). The RAPD analysis of the bark tissues of both rootstock and scion tissues revealed that there was genetic homogeneity among the scion tissues of a given clone, but the rootstocks showed appreciable variation (Sobhana *et al.*, 1999; Thomas *et al.*, 2000). In the present investigation, intraclonal variations in dry rubber yield, dry rubber content, plugging index and concentrations of sucrose, thiols and inorganic phosphorus in the latex were monitored for a period of two years.

The experiment was conducted utilizing twenty three healthy trees of the clone RRII 105 selected at random from 400 trees, which were planted in an estate at Kottayam in 1985 and opened for tapping in 1992. The tapping systems adopted were 1/2S d/2, 6d/7 up to December 1995 and thereafter 1/2S d/3 6d/7. The study was started in January 1995 and the yield parameters were recorded monthly for a period of two years.

Dry rubber content (DRC) was determined by gravimetric method. Dry rubber yield (g/tree/tap) was computed by multiplying DRC with the volume of latex harvested in a single tapping from a tree.

Table 1. **Monthly variation in range, mean and CV of yield and yield attributes under 1/2S d/2 6d/7 tapping system (1995)**

Month	Yield			DRC			PI			Sucrose*			Inorganic P*			Thiols*		
	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV
January	9 - 56	23	46	36 - 43	39	6	3.8 - 11.8	7.2	29	130 - 517	260	36	32 - 64	46	21	6.4 -10.8	8.4	15
February	22 - 77	41	37	35 - 46	41	7	2.9 - 6.1	4.1	24	62 - 235	138	31	21 - 60	39	28	3.7 - 6.9	4.8	18
March	16 - 54	31	32	38 - 54	45	8	2.7 - 7.7	4.6	28	123 - 438	233	42	2 - 33	16	60	5.8 - 8.9	7.8	10
April	18 - 45	31	24	38 - 48	45	5	3.2 - 6.5	4.6	19	182 - 565	333	23	14 - 35	23	27	4.6 - 9.0	6.2	15
May	14 - 76	42	41	30 - 41	36	8	1.3 - 9.2	3.7	45	127 - 419	230	28	26 - 59	42	19	5.8 -11.1	8.9	12
June	14 - 70	41	36	30 - 41	35	8	1.7 - 7.9	3.6	3	100 - 348	185	42	31 - 65	46	17	8.1 -13.7	11.4	12
July	18 - 75	44	37	25 - 34	29	7	1.8 - 4.6	2.3	31	108 - 378	241	32	50 - 83	65	14	8.7 -16.5	12.7	13
August	19 - 127	64	37	28 - 42	32	9	1.6 - 4.4	2.4	29	70 - 389	189	42	59 - 91	71	13	10.7 -17.2	13.2	13
September	35 - 103	76	25	31 - 42	37	8	1.3 - 2.7	1.9	21	92 - 560	289	40	58 - 93	74	16	7.8 -14.4	11.3	15
October	43 - 115	75	27	34 - 44	38	7	2.0 - 3.9	2.6	17	154 - 624	349	36	40 - 92	64	22	10.8 -18.8	13.5	16
November	16 - 82	48	33	33 - 43	38	7	2.0 - 6.6	3.7	29	257 - 845	485	33	46 - 83	60	18	9.8 -15.8	12.7	12
December	46 - 95	65	22	33 - 46	40	9	2.1 - 4.1	2.8	19	270 - 954	534	37	22 - 74	43	33	6.4 -11.9	8.6	18

* mg/100g latex

Table 2. **Monthly variation in range, mean and CV of yield and yield attributes under 1/2S d/2 6d/7 tapping system (1996)**

Month	Yield			DRC			PI			Sucrose*			Inorganic P*			Thiols*		
	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV	Range	Mean	CV
January	5 - 26	12	44	37 - 47	43	6	7.4 - 16.0	12.2	18	331 -1195	829	28	9 - 71	37	42	6.3 - 13.7	9.9	24
February	10 - 42	24	40	39 - 49	44	6	5.9 - 20.0	9.6	37	122 - 535	245	41	29 -105	50	34	6.0 - 11.0	8.4	17
March	17 - 51	35	27	44 - 53	47	4	3.1 - 11.5	6.1	31	41 - 343	154	54	8 - 57	29	48	4.8 - 13.0	8.3	24
April	10 - 43	21	40	44 - 57	50	5	5.5 - 19.0	9.4	36	158 - 733	307	42	6 - 35	17	53	5.2 - 11.5	9.1	18
May	15 - 77	40	44	37 - 50	43	8	2.9 - 13.1	6.5	36	49 - 212	134	34	19 - 61	29	30	5.8 - 12.3	10.2	15
June	13 - 68	43	36	36 - 46	42	6	2.8 - 9.0	5.3	27	242 - 485	342	18	21 - 63	36	31	1.8 - 8.3	4.9	38
July	25 - 138	75	41	35 - 50	40	10	1.5 - 4.7	2.8	33	63 - 291	165	36	32 - 74	54	20	7.1 - 15.5	10.6	25
August	30 - 226	126	38	33 - 44	38	8	1.2 - 3.4	1.8	29	90 - 524	252	40	54 -100	70	17	4.1 - 10.2	7.3	29
September	52 - 193	100	36	31 - 42	37	8	1.1 - 3.3	2.1	26	62 - 383	201	45	50 -117	67	22	6.6 - 15.5	11.1	19
October	37 - 150	83	39	28 - 44	36	11	1.4 - 5.0	3.0	33	109 - 391	223	36	52 -124	72	22	2.3 - 11.8	7.7	34
November	19 - 63	40	30	34 - 46	41	7	3.3 - 9.2	5.3	27	141 - 528	329	33	48 -106	67	24	4.4 - 13.4	9.3	22
December	20 - 71	40	35	42 - 59	46	8	3.4 - 9.0	5.4	29	125 - 410	272	31	35 - 76	46	22	3.4 - 14.3	8.2	34

* mg/100g latex

Plugging index (PI) was determined after Milford *et al.* (1969). Latex samples collected between 5 to 30 min. were used for biochemical estimations. Duplicate samples were analysed individually for all trees. A known amount of latex was extracted with 2.5 per cent trichloroacetic acid and aliquots were used for estimations of sucrose (Scott and Melvin, 1953), inorganic P (Taussky and Shorr, 1953) and thiols (Boyne and Ellman, 1972).

The mean dry rubber yield varied from 12 to 126 g per tree per tap during the 24 months of study (Tables 1 and 2). As expected, the yield was low in the summer months and high in the months of August to October. The coefficient of variation of the monthly mean rubber yield ranged from 22 to 46 per cent which did not show any specific association with the season or the level of rubber yield.

The mean DRC varied from 29 to 50 per cent and its coefficient of variation ranged from 4 to 11 per cent. There were large variations in the mean PI computed for each month. The concentrations of sucrose, inorganic P and thiols present in the latex also showed large coefficient of variation for their respective means computed for each month. Among the variables studied, DRC showed smaller coefficient of variation throughout the year.

Path coefficient analysis was done taking yield as the dependent and DRC (x1), plugging index (x2), sucrose (x3), inorganic P (x4) and thiols (x5) as the independent variables. Results (Table 3) revealed that direct and indirect effects of plugging index and inorganic P on yield were significant. These two variables were almost equal in determining the variations in yield. The dry rubber content had moderate influence on yield, while the other two variables had no influence on yield. Inorganic P and plugging index were thus found to be important parameters determining the yield capability of a clone.

Sucrose is the basic substrate for rubber (polyisoprene) production. The higher concentration of sucrose in latex may indicate either an increased supply (Tupy and Primot, 1976) or low metabolic utilization (Prevot *et al.*, 1984) for rubber production. The inorganic phosphorus content indicates the energy metabolism of latex. Thiols present in latex act as antioxidants which are produced during the stress induced metabolic acitivity. Thiols can also activate some key enzymes like invertase and pyruvate kinase that increase metabolic activity and thereby result in the regeneration of latex (Jacob *et al.*, 1986).

In the present study, there were clear variations in yield and yield components

Table 3. Direct and indirect effects of yield attributes on yield

Parameter	Direct effect	Indirect effect					
		DRC (x1)	PI (x2)	Sucrose (x3)	Inorganic (x4)	Thiols (x5)	Total correlations
DRC (x1)	0.3984	—	-0.4524	0.0075	-0.4711	0.0491	-0.4685*
PI (x2)	-0.7004	0.2573	—	-0.0237	-0.3576	0.023	-0.754**
Sucrose (x3)	0.0566	0.0528	-0.2932	—	-0.0413	-0.0072	-0.2323NS
Inorganic P (x4)	0.6339	-0.2961	0.3952	-0.0037	—	-0.0454	0.06836**
Thiols (x5)	-0.0921	-0.2124	0.1752	0.0044	0.3122	—	0.1873NS

* Significant at P ≤ 0.05; ** Significant at P ≤ 0.01

among the individual trees of the clone RRII 105. Apart from the genetic heterogeneity of the rootstock, differences in the age of the budwood used for grafting, microclimate of individual trees and management practices also can be contributory factors for the large intraclonal variations. There were no apparent differences in the topography or soil type within the plantation. Cultural operations as per the standard package of practices were also followed in the estate. Hence, the large variations in yield and yield attributes observed in the present study may be contributed largely by the genetic variability of the rootstocks. Another possible source of variation is the age of the buds used for budding. Chandrashekar *et al.* (1993) have reported much higher coefficient of variation for dry rubber yield (60%) in clones GT 1 and RRIM 600 in non-traditional region than what is observed in RRII 105 clone in this study. The present study therefore, shows the existence of intraclonal variations which are not only in yield and yield attributes but also in the biochemical composition of the latex of the *Hevea* clone RRII 105, grown in a traditional rubber growing area.

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