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Daily Variations in Yield and Dry Rubber Content in Four Hevea *Clones*

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Variations in daily latex volume, dry rubber content and dry rubber yield in clones GT 1, PB 5/51, RRIM 600 and RRIM 701 tapped on S/2.d/2 and S/1.d/4 were studied for a year. Generally, daily latex volume, dry rubber content and dry rubber yield in all the four clones under S/2.d/2 tapping had the same trend with time. Hence, planters can assess the relative yield and dry rubber content in various fields tapped on the same day. However, the daily variations in the three yield attributes in trees tapped on S/1.d/4 were larger and there was a more variable trend among the four clones.

Latex is a fluid cytoplasm obtained by tapping *Hevea* trees at regular intervals. Rubber is a component of the latex, and in any tapping, dry rubber yield is a function of the latex weight and its percentage dry rubber content (d.r.c.). The actual rubber yield in each tapping depends on a number of factors, including clone, age of the tree, the tapping system[1,2], stimulation[3], depth of tapping[4,5] and slope of tapping cut[6,7].

The Rubber Research Institute of Malaysia (RRIM) has recommended a few common tapping systems for exploitation of widely cultivated *Hevea* clones. The most commonly used systems are S/2.d/2, S/2.d/3, S/R.d/4 and S/1.d/4[8]. Within a clone tapped on a particular system, the maximum yield is usually obtained in October to January and the minimum yield from February to April[9]. In addition to the seasonal yield variation, there are also daily yield and d.r.c. variations[10,11]. Little information, however, is available on these variations in *Hevea* clones tapped on different systems.

This paper describes the daily variations in latex volume, d.r.c. and dry rubber yield in four *Hevea* clones tapped on S/2.d/2 and S/1.d/4 over one year. A comparison between clones tapped on S/2.d/2 and S/1.d/4 was made. It is hoped that this information can assist planters in assessing the crop yield in neighbouring fields tapped on the same day.

MATERIALS AND METHODS

Clones GT 1, PB 5/51, RRIM 600 and RRIM 701 were grown in large monoclonal blocks (about 3 ha per clone) in Malakoff Estate, Padang Serai, Penang. Clones GT 1 and PB 5/51 were in the sixth year of tapping whereas RRIM 600 and RRIM 701 were in the fifth year of tapping Prior to the experiment the trees were tapped on the S/2.d/2 system for ten tappings and from the volumes of latex produced forty-eight trees were allotted to each tapping system. For the S/2.d/2 system, the forty-eight trees were again divided into two groups of twenty-four trees each. For the S/1.d/4 system, the trees were divided into four groups of twelve trees each. The trees in all the groups within any tapping system were chosen in such a way that the trees in each group had approximately equal yield potential.

On each tapping day, twenty-four trees on the S/2.d/2 system and twelve trees on the S/1.d/4 system in each clone were

COMMUNICATION 644

tapped. In the S/2.d/2 system, all the trees tapped on the first day were marked *B* and those on the second day were marked *C*. In the S/1.d/4 system, the trees were marked *J*, *K*, *L* and *M* for the four tapping days. Trees in *Group B* on the S/2.d/2 system were tapped on the same day as trees in *Group J* and again on the same day as trees in *Group L* on the S/1.d/4 system. Similarly, trees in *Group C* were tapped on the same day as *Group K* and again on the same day as trees in *Group M*. Tapping began at 0630 h and was completed at 0800 h daily.

The volume of latex (millilitres per tree per tapping) for each tree was measured at 1130 h, except during the peak yielding months (October to January) when it was measured at 1230 hours. The latex from all the trees in each system was then poured into a clean can and the bulk weight of the latex was recorded. Forty-five millilitre latex samples were taken from each system for d.r.c. determination[12]. The dry rubber yield (grammes per tree per tapping) was expressed as the product of the latex weight and the d.r.c. over the number of trees tapped in each tapping. This experiment was carried out from 1 August, 1972 to 31 July 1973 covering the following four seasonal quarters:

- August to October (high-yielding months)
- November to January (peak-yielding months)
- February to April (wintering months)
- May to July (post-wintering months)

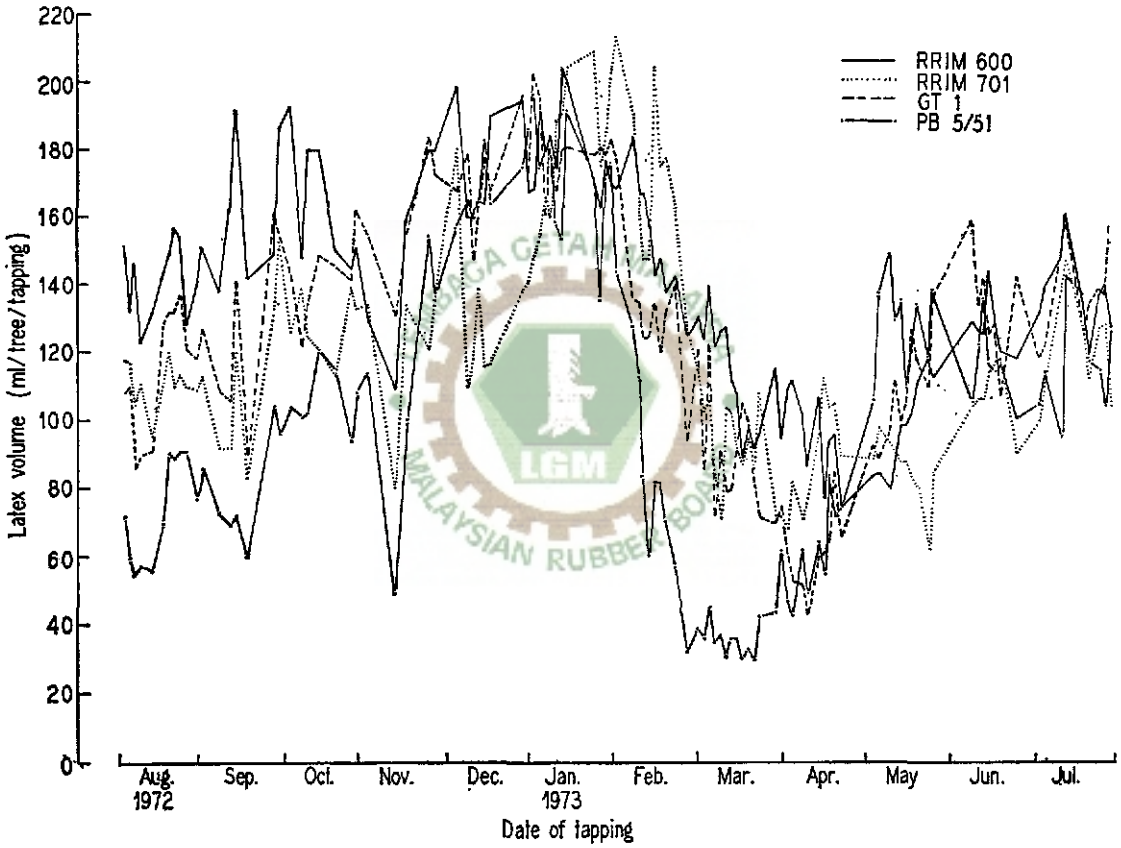

Figure 1. General trend in latex volume of four clones tapped on the S/2.d/2 system.

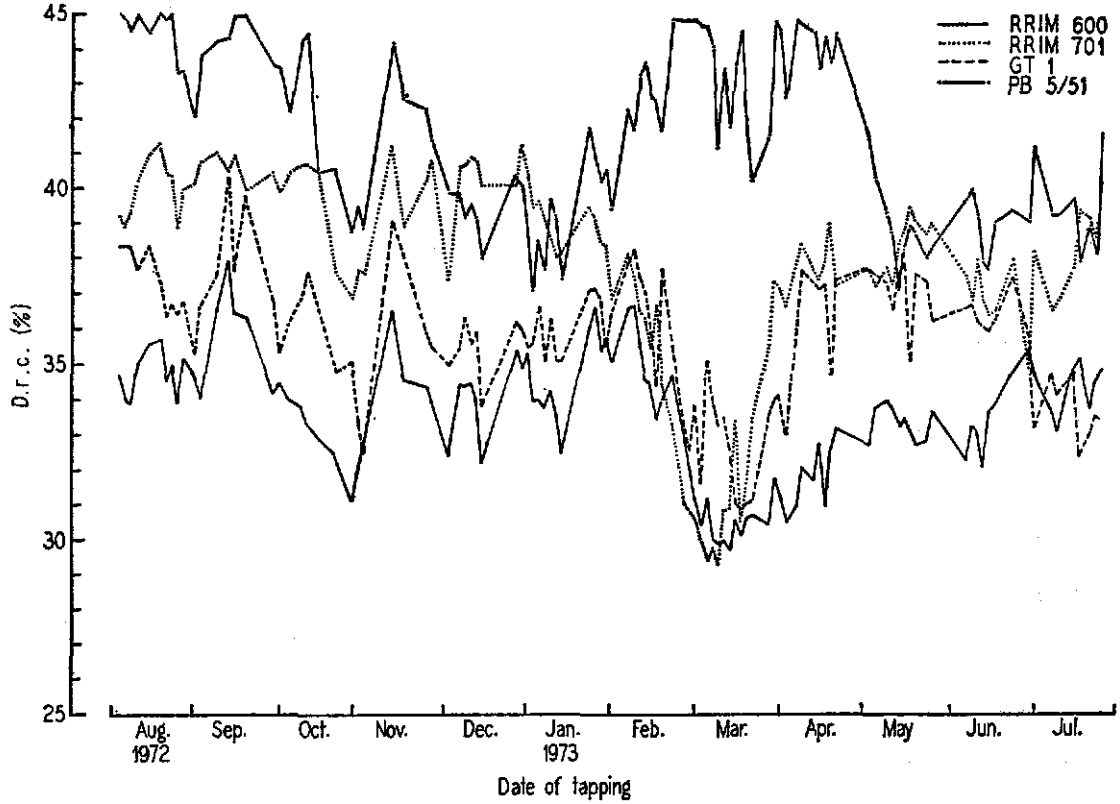

Figure 2. General trend in percentage dry rubber content of four clones tapped on the S/2.d/2 system.

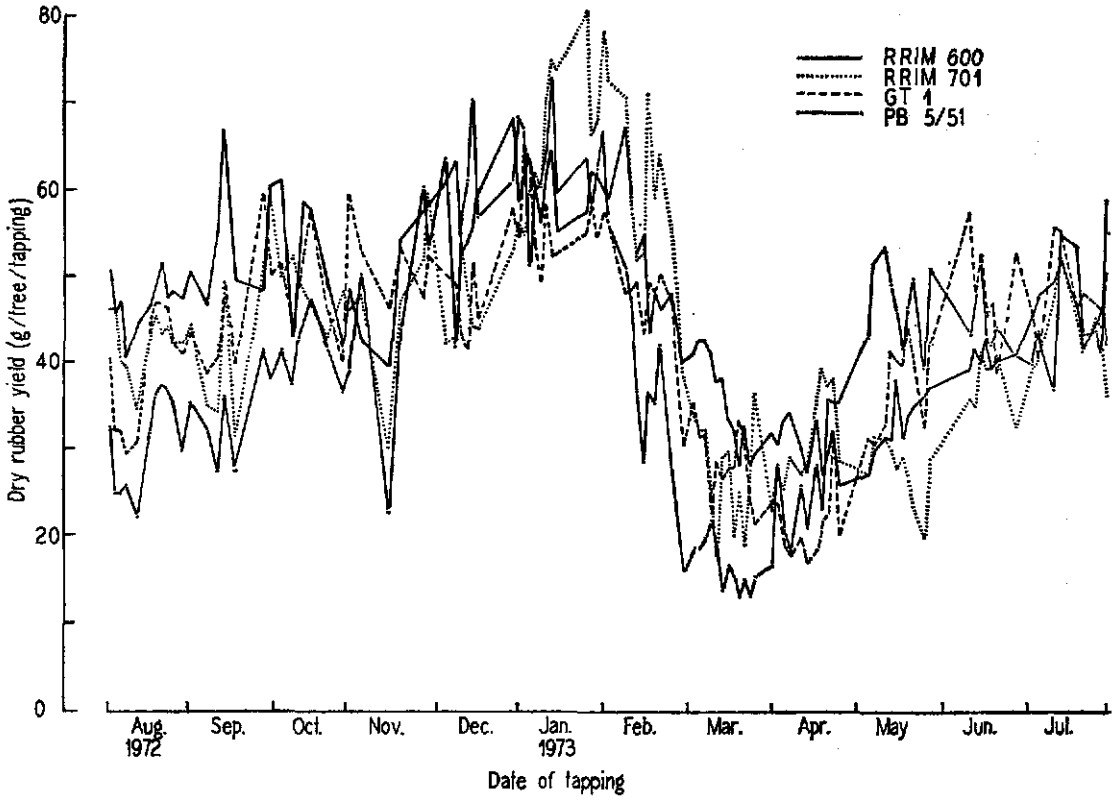

Figure 3. General trend in dry rubber yield of four clones tapped on the S/2.d/2 system.

TABLE 1. MEANS, DAILY STANDARD DEVIATIONS AND COEFFICIENTS OF VARIATION OF LATEX VOLUME, DRY RUBBER CONTENT AND DRY RUBBER YIELD FOR FOUR *HEVEA* CLONES TAPPED ON THE S/2.D/2 SYSTEM

Item	August–October 1972	November 1972 – January 1973	February–April 1973	May–July 1973	August 1972 – July 1973
GT 1					
Latex volume (ml/tree/tapping)	122.8±19.5 (15.9%)	161.9±19.1 (11.8%)	90.3±33.0 (36.5%)	112.3±23.0 (20.5%)	118.5±24.3 (20.5%)
D.r.c. (%)	36.9±1.4 (3.8%)	35.7±1.4 (3.9%)	34.6±2.5 (7.2%)	35.9±1.3 (3.6%)	35.6±1.7 (4.8%)
Dry rubber yield (g/tree/tapping)	42.9±6.0 (14.0%)	50.5±5.8 (11.5%)	31.3±11.8 (37.7%)	39.4±8.0 (20.3%)	39.9±8.3 (20.8%)
PB 5/51					
Latex volume (ml/tree/tapping)	85.1±19.5 (22.9%)	147.5±31.2 (21.2%)	63.5±26.8 (42.2%)	121.4±14.3 (11.8%)	100.5±23.9 (23.8%)
D.r.c. (%)	43.1±1.9 (4.4%)	40.2±1.6 (4.0%)	43.6±1.5 (3.4%)	39.1±1.0 (2.6%)	41.6±1.5 (3.6%)
Dry rubber yield (g/tree/tapping)	34.0±6.0 (17.6%)	54.1±10.6 (19.6%)	27.2±10.6 (39.0%)	45.7±5.3 (11.6%)	38.9±2.6 (6.7%)
RRIM 600					
Latex volume (ml/tree/tapping)	155.1±20.3 (13.1%)	168.3±24.6 (14.6%)	124.8±27.4 (22.0%)	126.1±18.5 (14.7%)	140.2±23.0 (16.4%)
D.r.c. (%)	34.1±1.5 (4.4%)	34.5±1.5 (1.2%)	32.6±2.2 (1.5%)	33.9±0.9 (0.9%)	33.7±1.6 (0.6%)
Dry rubber yield (g/tree/tapping)	49.5±6.9 (13.9%)	55.9±7.1 (12.7%)	40.5±10.7 (26.4%)	39.9±6.2 (15.5%)	45.7±7.9 (17.3%)
RRIM 701					
Latex volume (ml/tree/tapping)	117.4±16.8 (14.3%)	152.7±38.5 (25.2%)	111.7±43.2 (38.7%)	115.0±19.0 (16.5%)	120.7±31.6 (26.2%)
D.r.c. (%)	40.0±1.0 (2.5%)	39.5±1.5 (3.8%)	34.7±3.1 (8.9%)	38.1±1.2 (3.2%)	37.7±1.9 (5.0%)
Dry rubber yield (g/tree/tapping)	44.2±6.3 (14.3%)	56.3±13.0 (23.1%)	37.0±15.3 (41.4%)	36.2±7.5 (20.7%)	42.8±9.3 (21.7%)
Average of all clones					
Latex volume (ml/tree/tapping)	120.1±19.1 (15.9%)	157.6±29.3 (18.6%)	97.6±33.0 (33.8%)	118.7±19.0 (16.0%)	120.0±25.9 (21.6%)
D.r.c. (%)	37.9±1.5 (4.0%)	37.4±1.5 (4.0%)	36.4±2.4 (6.6%)	36.7±1.1 (3.0%)	37.2±1.7 (4.6%)
Dry rubber yield (g/tree/tapping)	42.7±6.4 (15.0%)	54.2±9.6 (17.7%)	34.0±12.2 (35.9%)	40.3±6.8 (16.9%)	41.8±8.5 (20.3%)

Numbers of recorded tappings for quarters 1, 2, 3 and 4 are 49, 47, 70 and 51 respectively.
Figures within brackets are coefficients of variation of latex volume.

TABLE 2. MEANS, DAILY STANDARD DEVIATIONS AND COEFFICIENTS OF VARIATION OF LATEX VOLUME, DRY RUBBER CONTENT AND DRY RUBBER YIELD FOR FOUR *HEVEA* CLONES TAPPED ON THE S/1.D/4 SYSTEM

Item	August–October 1972	November 1972–January 1973	February–April 1973	May–July 1973	August 1972–July 1973
GT 1					
Latex volume (ml/tree/tapping)	186.6±30.2 (16.2%)	200.7±35.1 (17.5%)	174.4±60.6 (34.8%)	203.4±42.1 (20.7%)	189.3±43.5 (23.0%)
D.r.c. (%)	34.2±1.0 (2.9%)	35.3±1.9 (5.4%)	31.4±3.1 (9.9%)	33.0±1.6 (4.9%)	33.2±2.0 (6.0%)
Dry rubber yield (g/tree/tapping)	62.0±10.4 (16.8%)	71.9±12.8 (17.8%)	57.7±22.7 (39.3%)	65.9±11.5 (17.5%)	63.7±15.2 (23.9%)
PB 5/51					
Latex volume (ml/tree/tapping)	153.6±40.2 (26.2%)	199.4±37.5 (18 8%)	104.3±50.7 (48.6%)	147.7±26.3 (17.8%)	145.0±39.6 (27.3%)
D.r.c. (%)	41.7±1.9 (4.6%)	41.8±2.1 (5 0%)	43.2±2.2 (5.1%)	40.7±1.9 (4.7%)	42.0±2.0 (4.8%)
Dry rubber yield (g/tree/tapping)	62.6±15.0 (24.0%)	83.3±15.8 (19.0%)	44.8±20.7 (46.2%)	58.3±9.2 (15.8%)	59.9±15.7 (26.2%)
RRIM 600					
Latex volume (ml/tree/tapping)	298.3±51.7 (17.3%)	214.6±31.6 (14.7%)	203.9±27.0 (13.2%)	274.5±60.2 (21.9%)	244.3±44.9 (18.4%)
D.r.c. (%)	32 8±2.8 (8.5%)	33.9±2.0 (5.9%)	31.3±2.7 (8.6%)	31.1±4.3 (13.8%)	32.0±2.3 (7.2%)
Dry rubber yield (g/tree/tapping)	91.4±18.4 (20.1%)	72.7±9.7 (13.3%)	63.7±10.4 (16.3%)	84.6±19.1 (22.6%)	87.7±15.4 (17.6%)
RRIM 701					
Latex volume (ml/tree/tapping)	184.2±32.8 (17.8%)	219.2±38.1 (17.4%)	121.0±53.0 (43.8%)	141.3±28.1 (19.9%)	160.5±39.1 (24.4%)
D.r.c. (%)	40.1±4.9 (12.2%)	39.4±1.4 (3.6%)	35.7±2.6 (7.3%)	37.1±1.6 (4.3%)	37.6±3.0 (8.0%)
Dry rubber yield (g/tree/tapping)	65.3±12.6 (19.3%)	80.2±16.2 (20.2%)	41.7±19.6 (47.0%)	48.8±11.1 (22.8%)	56.6±15.2 (26.9%)
Average of all clones					
Latex volume (ml/tree/tapping)	205.7±39.6 (19.3%)	208.5±35.6 (17.1%)	150.9±56.4 (37.4%)	191.9±41.5 (21.6%)	184.8±41.8 (22.6%)
D.r.c. (%)	36.4±3.0 (8.2%)	37.6±1.8 (4.8%)	35.4±2.7 (7.6%)	34.6±1.6 (4.6%)	36.2±2.4 (6.6%)
Dry rubber yield (g/tree/tapping)	70.3±14.4 (20.5%)	77.0±14.8 (19.2%)	57.0±19.0 (33.3%)	64.4±13.3 (20.7%)	67.0±15.4 (23.0%)

Numbers of recorded tappings for quarters 1, 2, 3 and 4 are 49, 41, 70 and 51 respectively.
Figures within brackets are coefficients of variation of latex volume.

To increase the number of recorded tappings in each quarter, the yield data for the two groups of trees tapped on the S/2.d/2 system and those of the four groups of trees tapped on the S/1.d/4 system were analysed together.

RESULTS

Yield Performance

Tables 1 and *2* summarise the mean latex volume d.r.c. and dry rubber yield for all the four clones tapped on the S/2.d/2 and S/1.d/4 systems. Generally, the highest latex volume and dry rubber yield were obtained in November to January and the minimum yield in February to April for all the four clones. Moderately good yields were recorded in the other two seasonal quarters. In most cases, d.r.c. was lower in the wintering months than in the other quarters. Clone RRIM 600 gave the highest yield and the lowest d.r.c. whereas clone PB 5/51 gave the lowest yield and the highest d.r.c. in both S/2.d/2 and S/1.d/4 systems.

Daily Yield Trend

The general trend in daily volume of latex of the four clones tapped on the S/2.d/2 system over one year is shown in *Figure 1.* During this period, high latex volume in one clone generally corresponded to high latex volume in the other clones tapped on the same day. In the S/1.d/4 system, there was little similarity in the daily yield trend among the four clones, particularly during the higher yielding quarters. For daily d.r.c. and dry rubber yield, similar trends were also observed for the four clones tapped on the S/2.d/2 system *(Figures 2* and *3).* These were, however, not obvious in the S/1.d/4 system.

Correlation Studies

Tables 3–5 show the between-clone correlation coefficients for the three yield attributes. The correlation coefficients for these yield attributes were generally higher in the S/2.d/2 system than in the S/1.d/4 system. In the S/2.d/2 system, between-clone correlations in daily latex volume,

TABLE 3. BETWEEN-CLONE CORRELATION COEFFICIENTS FOR DAILY LATEX VOLUME

Tapping system	GT 1 vs PB 5/51	GT 1 vs RRIM 600	GT 1 vs RRIM 701	RRIM 701 vs PB 5/51	RRIM 701 vs RRIM 600	RRIM 600 vs PB 5/51	Pooled[a]
August–October 1972							
S/2.d/2	0.78***	0.57***	0.67***	0.70***	0.40**	0.47***	0.61***
S/1.d/4	0.07NS	0.19NS	0.14NS	0.58***	0.07NS	0.39**	0.25NS
November 1972 – January 1973							
S/2.d/2	0.67***	0.65***	0.28NS	0.37*	0.59***	0.62***	0.55***
S/1.d/4	0.30NS	0.05NS	−0.14NS	−0.07NS	0.06NS	0.03NS	0.04NS
February–April 1973							
S/2.d/2	0.48***	0.76***	0.82***	0.53***	0.74***	0.48***	0.66***
S/1.d/4	0.81***	0.07NS	0.47***	0.67***	0.24*	0.28*	0.47***
May–July 1973							
S/2.d/2	0.05NS	0.53***	0.46**	0.07NS	0.69***	−0.17NS	0.30*
S/1.d/4	0.30*	0.45***	0.23NS	−0.29*	0.39**	−0.39**	0.02NS

[a]Pooled results calculated with Z transformation.

TABLE 4. BETWEEN-CLONE CORRELATION COEFFICIENTS FOR DAILY DRY RUBBER CONTENT

Tapping system	GT 1 vs PB 5/51	GT 1 vs RRIM 600	GT 1 vs RRIM 701	RRIM 701 vs PB 5/51	RRIM 701 vs RRIM 600	RRIM 600 vs PB 5/51	Pooled[a]
August–October 1972							
S/2.d/2	0.60***	0.62***	0.38**	0.49***	0.59***	0.77***	0.59***
S/1.d/4	0.01NS	0.11NS	−0.19NS	−0.22NS	0.72***	−0.05NS	0.09NS
November 1972 – January 1973							
S/2.d/2	0.51***	0.74***	0.46**	0.14NS	0.37*	0.62***	0.50***
S/1.d/4	0.08NS	0.70***	0.18NS	−0.13NS	0.15NS	−0.17NS	0.16NS
February–April 1973							
S/2.d/2	−0.01NS	0.64***	0.70***	−0.11NS	0.41***	− 0.20NS	0.28*
S/1.d/4	0.29*	0.69***	0.23NS	0.24*	0.25*	0.03NS	0.31**
May–July 1973							
S/2.d/2	−0.01NS	−0.29*	−0.06NS	0.02NS	0.25NS	0.28*	0.03NS
S/1.d/4	−0.25NS	−0.12NS	0.05NS	0.23NS	−0.04NS	0.17NS	0.02NS

[a]Pooled results calculated with Z transformation.

TABLE 5. BETWEEN-CLONE CORRELATION COEFFICIENTS FOR DAILY DRY RUBBER YIELD

Tapping system	GT 1 vs PB 5/51	GT 1 vs RRIM 600	GT 1 vs RRIM 701	RRIM 701 vs PB 5/51	RRIM 701 vs RRIM 600	RRIM 600 vs PB 5/51	Pooled[a]
August–October 1972							
S/2.d/2	0.77***	0.61***	0.57***	0.66***	0.46***	0.52***	0.61***
S/1.d/4	0.07NS	0.42**	−0.13NS	0.38**	0.08NS	0.15NS	0.17NS
November 1972 – January 1973							
S/2.d/2	0.28NS	0.54***	0.40**	0.48***	0.44**	0.55***	0.45***
S/1.d/4	0.35*	0.22NS	−0.26NS	0.09NS	0.27NS	0.07NS	0.10NS
February–April 1973							
S/2.d/2	0.66***	0.81***	0.77***	0.65***	0.73***	0.63***	0.72***
S/1.d/4	0.87***	0.18NS	0.50***	0.68***	0.03NS	0.17NS	0.47***
May–July 1973							
S/2.d/2	0.21NS	0.49***	0.43***	0.19NS	0.73***	0.03NS	0.37***
S/1.d/4	−0.21NS	0.52***	0.14NS	−0.21NS	0.39**	−0.39**	0.05NS

[a]Pooled results calculated with Z transformation.

d.r.c. and dry rubber yield were positive and highly significant in most cases, except in May to July where there was poor correlation in daily d.r.c. among the four clones. In the S/1.d/4 system, between-clone correlations for these three yield attributes were generally poor in the high-yielding quarters. However, during the wintering months the correlation was positively significant in most of the cases.

Table 6 summarises the correlation between daily latex volume and d.r.c. of the four clones. In the S/2.d/2 system, there were highly significant negative correlations between latex volume and d.r.c. in a number of cases, whereas in the S/1.d/4 system, significant correlations were only established in a few cases. In the wintering months, there was one case of highly significant positive correlation between latex

TABLE 6. SIMPLE CORRELATION COEFFICIENTS BETWEEN LATEX VOLUME, DRY RUBBER CONTENT AND DRY RUBBER YIELD OF FOUR CLONES UNDER S/2.D/2 AND S/1.D/4 TAPPING SYSTEMS

Clone	Correlation	Tapping system	Correlation coefficients				
			August–October 1972	November 1972 – January 1973	February–April 1973	May–July 1973	August 1972 – July 1973
GT 1	Latex volume and d.r.c.	S/2.d/2	−0.67***	−0.17NS	0.12NS	−0.51***	0.08NS
		S/1.d/4	0.23NS	−0.08NS	0.34**	−0.54***	0.21NS
PB 5/51		S/2.d/2	−0.55***	−0.57***	−0.35**	−0.04NS	−0.71***
		S/1.d/4	−0.55***	−0.22NS	−0.29*	+0.52***	−0.42***
RRIM 600		S/2.d/2	−0.21NS	−0.33*	0.57***	0.23NS	0.34***
		S/1.d/4	−0.06NS	−0.05NS	0.12NS	−0.02NS	0.46***
RRIM 701		S/2.d/2	−0.22NS	−0.78***	−0.10NS	−0.17NS	0.03NS
		S/1.d/4	0.13NS	−0.05NS	0.41***	0.36***	−0.02NS
GT 1	Dry rubber yield and d.r.c.	S/2.d/2	−0.43**	0.02NS	0.28*	−0.43**	0.21NS
		S/1.d/4	0.34*	0.08NS	0.54***	−0.38**	0.43**
PB 5/51		S/2.d/2	−0.38**	−0.40**	−0.30**	0.23NS	−0.64***
		S/1.d/4	−0.37**	−0.01NS	−0.26*	−0.23NS	−0.28**
RRIM 600		S/2.d/2	0.05NS	−0.05NS	0.74***	0.44**	0.52***
		S/1.d/4	0.00NS	−0.06NS	0.26*	0.19NS	0.12NS
RRIM 701		S/2.d/2	−0.09NS	−0.71***	0.07NS	−0.10NS	0.22*
		S/1.d/4	0.11NS	0.04NS	0.51***	0.47***	0.49***
GT 1	Latex volume and dry rubber yield	S/2.d/2	0.89***	0.72***	0.96***	0.97***	0.94***
		S/1.d/4	0.89***	0.65***	0.95***	0.93***	0.90***
PB 5/51		S/2.d/2	0.94***	0.81***	0.97***	0.87***	0.96***
		S/1.d/4	0.96***	0.86***	0.97***	0.92***	0.96***
RRIM 600		S/2.d/2	0.86***	0.78***	0.96***	0.96***	0.94***
		S/1.d/4	0.78***	0.77***	0.82***	0.97***	0.84***
RRIM 701		S/2.d/2	0.91***	0.99***	0.97***	0.95***	0.97***
		S/1.d/4	0.78***	0.91***	0.98***	0.95***	0.96***
Degrees of freedom		S/2.d/2	47	45	68	49	218
		S/1.d/4	47	39	70	49	214

NS: Not significant at $P < 0.05$
* $P < 0.05$
** $P < 0.01$
*** $P < 0.001$

volume and d.r.c. in the S/2.d/2 system. In the S/1.d/4 system, a few cases of such correlation were established in the wintering and the post-wintering months. In both the tapping systems, daily dry rubber yield was more closely associated with daily latex volume than with dry rubber content.

DISCUSSION AND CONCLUSION

Latex volume and dry rubber yield in both S/2.d/2 and S/1.d/4 systems in GT 1, PB 5/51, RRIM 600 and RRIM 701 were similar with respect to seasonal variation. This is a common phenomenon and is associated with rainfall, temperature and leaf maturity in *Hevea*. During the wintering months, there was little photosynthesis, rainfall was low and temperature was higher. Hence, yield was low. After wintering, favourable environmental conditions together with more mature leaves resulted in higher yield. Adijuwana and Soerianagara[13] noted the similar yield trend with respect to leaf maturity in other *Hevea* clones in Indonesia.

Higher latex volume and dry rubber yield in trees tapped on the S/1.d/4 system were consistent with those in the report of Ng *et al*[2]. Greater daily variations in latex volume, d.r.c. and dry rubber yield in the S/1.d/4 system were in keeping with the finding of Narayanan *et al*[10,11].

Clonal differences in d.r.c. and higher d.r.c. observed in the S/2.d/2 system were similar to those reported by Ng *et al*[2]. Generally, lower d.r.c. obtained during the wintering months and higher d.r.c. in the other quarters, particularly in August to October, agreed with the observation of Adijuwana and Soerianagara[13] that d.r.c. was lowest during refoliation and highest when the leaves had matured.

The daily yield trend and between-clone correlation of individual yield attributes reflected the performance of these clones in response to daily environmental changes. In the S/2.d/2 system, the four clones had fairly consistent responses to environmental changes during the four quarters of the year. High yield in one clone generally corresponded to high yield in the other clones tapped on the same day, although they were tapped by different tappers. Hence, planters can assess and compare the daily yield trend in various fields tapped on the same day. In the S/1.d/4 system the responses to environmental influences of the four clones were similar during wintering months. However, during the high-yielding quarters, clonal responses to environmental influences showed little similarity. Lee[14] and Lee and Tan[15] had reported that high temperature during flow was an important factor influencing yield of trees tapped on the S/2.d/2 system. In this system, high temperature was associated with low latex volume and high dry rubber content. Hence, there was frequent negative correlation between latex volume and dry rubber content. The occasional positive correlation between these two yield attributes in both the S/2.d/2 and S/1.d/4 systems from February to April and May to July may be due to the simultaneous decrease or increase in both latex volume and d.r.c. during refoliation and after leaf expansion.

The close association between daily latex volume and dry rubber yield in both the S/2.d/2 and S/1.d/4 systems suggested that latex volume was the dominant factor determining daily dry rubber yield in all the four clones. The influence of d.r.c. on daily dry rubber yield was smaller.

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