Journal of Plantation Crops 18 (Supplement) : 97–100

PHYSIOLOGICAL AND BIOCHEMICAL SUB COMPONENTS OF MAJOR YIELD COMPONENTS IN *HEVEA BRASILIENSIS* –CLONAL VARIATION IN BURSTING INDEX AND CARBOHYDRATE PATTERN

N. USHA NAIR, MOLLY THOMAS, S. SREELATHA, K. R. VIJAYAKUMAR, and P. J. GEORGE

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

ABSTRACT

Bursting index and distribution of sugars in four clones belonging to the high and low yielding groups were examined. The latex of low yielding clones with high plugging index was shown to have a significantly higher bursting index than that of high yielding clones with low plugging index. The sucrose content of latex of the low yielding clones was lower than that in the high yielding clones. However, the total carbohydrates were found to be higher in low yielding clones. The possible roles of these parameters in relation to yield performances are discussed.

INTRODUCTION

The four major yield components of a rubber tree are initial flow rate, length of the tapping cut, dry rubber content and plugging index. A model for quantifying rubber yield from the major yield components was developed by Sethuraj (1981). Accordingly, the yield of rubber obtained from a day's tapping is expressed by the equation:

$$Y = \frac{F.l.Cr}{P}$$

where Y is yield of rubber obtained from a tree each time it is tapped, F is the average initial flow rate per centimetre of tapping cut during the first 5 minutes after tapping, l is the length of the cut, p is the plugging index, which is a measure of the extent of latex vessel plugging and Cr is the rubber content. Though the contributions of major yield components towards dry rubber yield in *Hevea* are well understood, knowledge regarding the nature and relative significance of the subcomponents is limited.

The latex of *Hevea brasiliensis* can be considered as a cellular cytoplasm (Dickenson, 1964; Hebant and Defay, 1980; Hebant, 1981). Its characteristics at tapping indicates the physiological state of the laticiferous system. (Prevot et al. 1986). The two major limiting factors in latex production are flow and regeneration. The easier and longer the flow the greater the amount obtained and reciprocally. Likewise a plant's ability to replenish the drained latex after tapping, depending on intensity of tapping, limit the production of latex. Although the role of flow restricting process on the latex yield in *Hevea brasiliensis* is now well established (Boatman, 1966; Sethuraj, 1968; Southorn, 1969; Milford, Pardekooper and Ho, 1969), the reasons for the clonal variation in the extent of plugging is less understood. Clonal variation in two parameters *viz.*, bursting index and carbohydrate status in *Hevea brasiliensis* and their roles in the regulation of latex flow and production are discussed in this paper.

MATERIALS AND METHODS

Six trees each of clones RRII 105, PB 235, Ch 4 and Pil B84 were selected for the study from a completely randomised planting in the germplasm garden of the Central Experiment Station, RRII. For each clone the trees were selected based on their yield performance and the selected trees have yields around the mean values. Clones RRII 105 and PB 235 represent high yielders and Clones Ch 4 and Pil B 84 represent low yielders. The trees were in the second year of tapping in the BO 1 panel.

Plugging index was determined by the method of Milford et al (1969) and bursting index by the method of Ribaillier (1968). The observations were made during October-November 1987 which was the peak yield period. Total carbohydrates were extracted from a known amount of latex and estimated by the method of Scott and Melvin (1953). Reducing sugars were estimated by the method of Nelson (1944) and Somogyi (1937). Total sugars were estimated by the same method after acid hydrolysis of the nonreducing sugars.

RESULTS

Data on dry rubber yield, dry rubber content, total carbohydrates, nonreducing sugars and reducing sugars are presented in Table I. The dry rubber yields of the low yielders were around 80% less than that of high yielders. The dry rubber contents were also low for the low yielders. The concentrations of total carbohydrates were higher for the low yielders when compared to those of the high yielders. The concentrations of nonreducing sugars were however high in the latices of high yielders. A definite pattern was not found in the concentration of reducing sugars in the latices of high and low yielders.

Data on plugging indices, initial flow rates, total volumes and bursting indices are presented in Table II. Plugging indices were low for high yielders. Initial flow rates and total volumes were high for the high yielders when compared to those of low yielders. Bursting indices were high for the low yielders when compared to those of the high yielders.

DISCUSSION

The observation that high yield of dry rubber is associated with high dry rubber contents in the latices and lower values of plugging indices is in conformity with the earlier findings of Sethuraj, et al, 1980. The associated lower values of bursting

Table I. *Dry rubber yield, dry rubber content, total carbohydrates, non reducing sugars and reducing sugars in four clones of* Hevea

Clone	Yield of rubber (gm tree^{-1} tap^{-1})	Dry rubber content (%)	Total carbohydrates (mg gm^{-1}) fresh wt)	Non reducing sugars (mg gm^{-1} fresh wt)	Reducing sugars (mg gm^{-1} fresh wt)
Ch 4	25.29	35.29	8.58	0.79	0.492
Pil B 84	18.05	35.08	9.84	0.72	0.758
RRII 105	97.75	39.98	5.82	3.90	0.966
PB 235	104.41	41.45	3.90	3.4	0.446
CD 0.05	10.05	2.15	1.65	0.47	0.077

Table II. *Plugging index, initial flow rate, total volume and bursting index of four* Hevea *clones*

Clone	Plugging index	Initial flow rate (ml min^{-1} $tree^{-1}$)	Initial flow rate (ml min^{-1} cm^{-1})	Total volume (ml)	Bursting index
Ch 4	5.54	2.36	0.064	71.48	36.41
Pil B 84	7.04	2.00	0.058	54.77	30.20
RRII 105	3.53	7.84	0.187	271.28	21.20
PB 235	2.78	4.80	0.093	279.55	16.12
CD 0.05	1.23	0.667	0.026	17.35	4.89

indices with lower values of plugging indices are also in agreement with the earlier findings (Ribaillier, 1968; Sherief and Sethuraj, 1978). The lower bursting indices observed in the latices of high yielders indicate better stabilities of the lutoids of these clones. The delay in plugging is often associated with better stability of lutoids.

The higher concentrations of carbohydrates in the latices of low yielders might be associated with low utilisation of the same for rubber biosynthesis. However, the higher sucrose concentrations in the latices of high yielders are associated with higher rubber production which is in agreement with earlier findings (Eschbach et al., 1984; D' Auzac and Pujarniscle, 1961). Under many situations negative correlations have also been reported (Jacob et al., 1985). The lower plugging indices of high yielders are due to large volumes of latex in spite of higher initial flow rates. Eventhough, the total volumes are comparable for clones RRII 105 and PB 235, a low plugging index for PB 235 is due to lower initial flow rate and prolonged duration of flow. The higher initial flow rate and higher plugging index for clone RRII 105 might be associated with higher turgor pressure in the latex vessels of RRII 105. However, more studies are essential on the pressure and osmotic potentials of the laticiferous systems of different clones.

REFERENCES

BOATMAN, S. G. 1966. Preliminary physiological studies on the promotion of latex flow by plant growth regulators. *J. Rubb. Res. Inst. Malaya.* **19** (5): 243–258.

DICKENSON, P. B. 1964. The ultrastructure of the latex vessel of *Hevea brasiliensis*. *Proc. nat. Rubb. Prod. Res. Ass. Jub. Conf. Cambridge* 1965. 52 London: Maclaren and Sons Ltd.

D, AUZAC, J. and PUJARNISCLE, S. 1961. Apercu sur l'etude des glucides de l' Hevea et sur leur variation *Rev. gen. caout.* **38**: (7–8) 1131.

ESCHBACH, J. M., ROUSSEL, D., VAN DE SYPE, H. and JACOB, J. L. 1984. Relationships between yield and clonal physiological characteristics of latex from *Hevea brasiliensis*. *Physiol. Veg.* **22** (3) : 295–304.

HEBANT, C. 1981. Laticiferous ontogeny of the primary system of *Hevea brasiliensis*. An ultrastructural and cytochemical study. *Can J. Bot.* **59** (6) : 974–978.

HEBANT, C. and DEFAY, E. 1980. Functional organisation of the bark of *Hevea brasiliensis* (Rubber tree). *Z. Pflanzen Physiol.* **97**: 391–398.

JACOB, J. L., ESCHBACH, J. M., PREVOT, J. C. ROUSSEL, D., LACROTTE, R., CHRESTIN, H. and D'AUZAC, J. 1985. Physiological basis for latex diagnosis of the functioning of the laticiferous system in rubber trees. *Proc. Int. Rubb. Conf.* 1985 *Kuala Lumpur* **3** : 43–65.

MILFORD, G. F. J., PAARDEKOOPER, E. C. and HO CHAI YEE. 1969. Latex vessel plugging, its importance to yield and clonal behaviour. *J. Rubb. Res. Inst. Malaya.* **21** (3) : 274–282.

NELSON, N. 1944. A photometric adaptation of the Somogyi method for the determination of glucose. *J. Biol. Chem.* **153** : 375.

PREVOT, J. C., JACOB, J. L., LACROTTE, R., VIDAL, A., SERRES, E., ESCHBACH, J. M. and GIGAULTI, J. 1986. Physiological parameters of latex from *Hevea brasiliensis.* Their use in the study of the laticiferous system. Typology of functioning production mechanism, effect of stimulation. *Proc. of the IRRDB Rubber Physiology and Exploitation Meeting* 1986. *SCATC, Hainan, China* pp. 136–157.

RIBAILLIER, D. 1968. Action invitro de certain ions mineraux et composes organiques sur la stabilite des lutoides du latex d' *Hevea. Rev. gen Caout. Plast.* **45** (12) : 1395–1398.

SCOTT, T. A., and MELVIN, E. H. 1953. *Anal. Chem.* **25**: 1656.

SETHURAJ, M. R. 1968. Studies on the physiological aspects of rubber production. Theoretical considerations and preliminary observations. *Rubber Board Bull.* **9**: 47–62.

SETHURAJ, M.R., GURURAJA RAO, G., MANI, K. T. and KRISHNASWAMY, N. P. 1980. Yield component analysis in a few clones of *Hevea brasiliensis* Presented at Int. Rubb. Conf. 24–27 November, Kottayam, India.

SETHURAJ, M. R. 1981. Yield components in *Hevea brasiliensis.* Theoretical considerations. *Plant Cell and Environment.* **4** (1) : 81–83.

SHERIEF, P. M. and SETHURAJ, M. R. 1978. The role of lipids and proteins in the mechanism of latex vessel plugging in *Hevea brasiliensis. Physiol. Plant.* **42** (3) : 351–353.

SOMOGYI, M. 1937. A reagent for the copper iodometric determination of very small amounts of sugar. *J. Biol. chem.* **117**: 771.

SOUTHORN, W. A. 1969. Physiology of *Hevea* (Latex flow) *J. Rubb. Res. Inst. Malaya* **21**(4) 494–512.