Proceedings of National Seminar on Drought Management in Plantation Crops, 1996, Kottayam, Kerala.

PHYSIOLOGICAL ASPECTS RELATED TO MAJOR YIELD COMPONENTS AND THEIR IMPLICATIONS TO DROUGHT IN *HEVEA BRASILIENSIS*

D.B. NAIR, M.B.M. SATHIK, USHA NAIR, K.R.VIJAYAKUMAR, JAMES JACOB and M.R. SETHURAJ

Rubber Research Institute Of India, Kottayam 686 009, India

ABSTRACT

Hevea brasiliensis is widely grown in India as a rainfed crop. Rubber yield depends upon various parameters that affect the flow characteristics of latex and in vitro regeneration of rubber. Severe drought will reduce rubber yield by affecting these two mechanisms. In the present study, effects of drought on various flow characteristics were assessed in nine clones. The decline in crop yield in summer months was characterised by low initial flow rate (F), high plugging index (PL) and increased dry rubber content (DRC) of latex while these changes were considerably reversed during wet season. The various clones did show the marked changes in their turgor pressure of laticiferous cells. The results suggests that soil moisture is an essential factor determining the flow characteristics of latex and therefore the yield of rubber.

INTRODUCTION

Occurence of seasonal and clonal variations in yield and yield components in Hevea is well known (Sethuraj and Mathew, 1992., Auzac et al., 1989). Among the many environmental variables that affect yield directly or indirectly, drought and temperature are the two most important ones affecting the flow characteristics of latex. In summer months, the atmospheric and soil drought prevails with very high evaporative demand and the rubber trees experience severe moisture deficit. Hevea plants undergo several metabolic changes in response to drought. The return of rainfall at the end of dry season recharges the soil and increases the quality and quantity of latex. Though the physiological parameters of yield depend on many factors, an attempt has been made in this study to describe different clones by comparing measurements carried out under analogous conditions during wet and dry months.

MATERIALS AND METHODS

The study was conducted at the Rubber Research Institute of India, Central Experiment Station, Chethackal (9° 22' N : 76° 50' E) in Kottayam district of Kerala. The clones selected are RRII 105, PB 235, PB 215, PB 217, Ch 4 and GT 1 (high yielding clones) and Pil B 84, Tjir 16 and

Ch 29 (low yielding clones) planted in 1977. Observations on yield (gm tree^{-1} tap^{-1}), and yield components including initial flow rate, F (ml cm^{-1} min^{-1}), turgor pressure, TP (bar), plugging index, PI and dry rubber content, DRC (%) were conducted in the months of March (dry) and June (wet) 1994 in nine clones with four replications for each clone.

Pre - tapping latex vessel turgor was reccorded using disposable manometers comprising No. 49 polythene surgical tubings sealed at one end and fitted with 21 guage hypodermic syringe needle at the other end (Raghavendra et al., 1984). Plugging index was calculated according to Milford et al. (1969). The trees were under 1/2 S d/2 system of tapping and were rainguarded during the rainy season. Soil moisture content (%) was estimated gravimetrically at three depths, from 0-30, 30-60 and 60-90. Weather parameters were collected from Central Experiment Station, Chethackal.

RESULTS

Variations in temperature, relative humidity, rainfall and soil moisture for the months of March and June are presented in Table 1. During March the rainfall was poor, the air temperature as well as evaporation was high and the soil moisture was low compared to June, where the rainfall was moderate and the soil water was found to be at the field capacity.

TABLE 1.

Variations in mean air temperature, relative humidity, evaporation, monthly rainfall and soil moisture in different months from Central Experiment Station, Chethackal.

	MARCH	JUNE
Maximum temperature (°c)	35.87	29.43
Minimum temperature (°c)	21.12	22.94
Evaporation (mm)	3.99	2.26
Total rainfall (mm)	18.4	497.5
Relative humidity (%)		
7 AM	87.81	93.71
2 PM	47.45	77.37
Soil moisture (%)		
0 - 30	18.0	Saturated
30- 60	20.3	Saturated
60- 90	22.2	Saturated

Clonal variations in latex flow rate, turgor pressure, plugging index, dry rubber content and latex yield are shown in Figure 1. In general there was an increase in the rate of initial flow of latex in the month of June (Fig. 1 A), except in clones Tjir 16 and Ch 4, where the initial flow of latex decreased at the rate of 0.03 ml min^{-1} cm^{-1} . Increased latex vessel turgor was noticed in all clones in the month of June, except in PB 217 and Ch 29 (Fig. 1 B). Plugging index decreased in the range of 5% (PB 215) to 55% (PB 235) in the month of June compared to March. In summer high PI values were reccorded in Tjir 16, Ch 29 and Pil B 84. Very low PI values were noticed in the month of June in clones PB 217, PB 235 and RRII 105 (Fig. 1 C). Dry rubber content, another major yield component was found higher in dry season than in wet season (Fig. 1 D). An overall 12% decrease in DRC was observed in the month of June. Dry rubber content decreased in the range of 3% (PB 235) to 18% (Pil B 84 and Tjir 16). Seasonal variation in latex production was prominent with high yield in wet season and low yield in dry season (Fig. 1 E). In total 53% accumulative rubber production was observed in June. In the month of March an overall 34% yield depression was observed compared to the wet season.

DISCUSSION

From the results obtained it is clear that high temperature and the absence of rainfall, characteristic of dry period created adverse conditions for latex production in Hevea. Very low yield reccorded in summer months in some clones is indicative of their increased succeptability to drought. This is in contrast to another rubber yielding plant Guayule (Parthenium argentatum), where water stress plays an important role in rubber particle accumulation (Reddy and Das, 1988). Thus Hevea exhibits its own distinct physiological response to water stress. In summer, relatively the high yielding clones responded by higher yield depressions than the low yielding ones. Seasonal variations also influenced the yield components of Hevea latex production. These findings have been made by other workers (Vijayakumar et al., 1988), Gururaja Rao et al., 1990 and Chandrasekhar et al., 1990). Clonal variations in latex yield was associated with differences in latex vessel turgor, dry rubber content, initial flow rate and plugging index. Inter-relationships among yield, yield component factors and soil moisture were described by Chandrasekhar (1994). Dry rubber content and plugging index were found to be the important yield component factors influenced by soil moisture. Sethuraj and Raghavendra (1984) observed a reduction in duration of flow and amount of latex in Hevea under water stress conditions. Decreased latex yield in dry season was due to enhanced plugging and restricted drainage area (Sethuraj and George, 1976). Though the physiological parameters of yield depend upon many factors, from these observations it is clear that the availability of moisture in the soil has a beneficial effect on latex production and also the response of individual clones to soil moisture deficit varied considerably. The study may serve as a tool to integrate various parameters related to projection of yield during drought and identify the clones with promising physiological profiles.

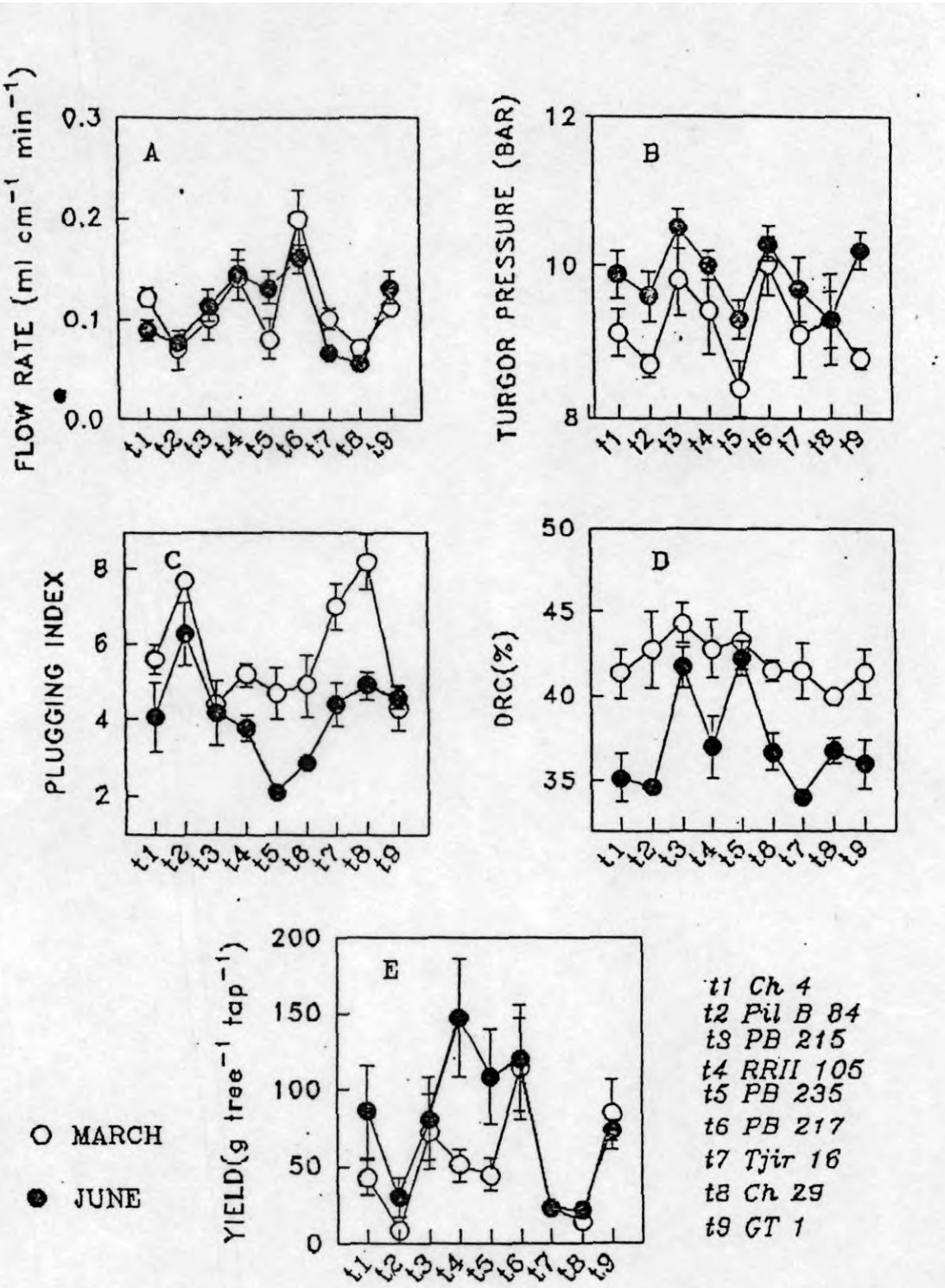

FIG.1. Variations in major yield components of nine clones of Hevea in dry (March) and wet (June) months.

ACKNOWLEDGEMENTS

We thank Dr. P.J. George and Dr. Susil Kumar Dey for the suggestions and usefull discussions.

REFERENCES

1. Auzac(d'), J., Jacob, J.K. & Chrestin, H. 1989. Physiology of rubber tree latex (Ed.). CRC press. Inc. Florida. (p) 470.

2. Chandrashekar, T.R., Jana, M.K., Thomas, J., Vijayakumar, K.R. & Sethuraj, M.R., 1990. Seasonal changes in physiological characteristics and yield in newly opened trees of Hevea brasiliensis in North Konkon. Indian Journal of Natural Rubber Research. 3 (2) : 88-97.

3. Chandrashekar, T.R. 1994. Correlation and path analysis of yield and its components, some factors of water relations and soil moisture in Hevea brasiliensis. Indian Journal of Natural Rubber Research. 7 (2) : 89-94.

4. Gururaja Rao, G., Sanjeeva Rao, P., Rajagopal, R., Devakumar, A.S., Vijayakumar, K.R. & Sethuraj, M.R. 1990. Influence of soil, plant and mateorological factors on water relations and yield in Hevea brasiliensis. International Journal of Biometeorology. 34 : 175-180.

5. Milford, G.F.J., Paardekooper, E.C. & Ho, C.V. 1969. Latex vessel plugging : its importance to yield and clonal behaviour. Journal of Rubber Research Institute of Malaya. 21 : 274-282.

6. Raghavendra, A.S. Sulochanamma. S., Gururaja Rao G., Mathew,S., Satheesan, K.V. & Sethuraj, M.R. 1984. The pattern of latex flow in relation to clonal variation, plugging and drought tolerance in Hevea. Proceedings IRRDB Colloque Exploitation Physiologie I'Hevea. Montpellier, France. 205-216.

7. Reddy, A.R. & Das, V.S.R. 1988. Enhanced rubber accumulation and rubber transferase activity in guayule under stress. Journal of Plant Physiology. 133 : 152-155.

8. Sethuraj, M.R. & George. M.J. 1976. Drainage area of bark and soil moisture content as factors influencing latex flow in Hevea brasiliensis. Indian Journal of Plant Physiology. 19 : 12-24.

9. Sethuraj, M.R. & Raghavendra, A.S. 1984. The pattern of latex flow from rubber tree Hevea brasiliensis in relation to water stress. Journal of Cell Biochemistry. Suppl. 8 B : 236.

10. Sethuraj, M.R. & Mathew, N.M. 1992. Natural rubber : biology, cultivation and technology. Elsevier Publishers. Amsterdam. (p) 610.