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GROWTH REACTION OF *HEVEA BRASILIENSIS* TO HEAT AND DROUGHT STRESS UNDER DRY SUBHUMID CLIMATIC CONDITIONS

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Growth pattern of *Hevea brasiliensis* in the Konkan region of India was studied. Data on environmental conditions and girth of plants were collected on monthly basis during the seventh year of planting. The region received rain only for about four months (June-September) and had more than seven months of dry period. In summer months ambient temperatures during daytime crossed 36°C and soil moisture deficits were severe. Growth occurred during the monsoon period only. Immediately after the monsoon, though there were no apparent limiting factors, the growth of plants stopped completely. Towards the latter half of the dry period reduction in girth of trees ranging from 0.2 mm to 0.5 mm was observed. The results indicated that the conditions prevailing from October to May would prolong the immaturity period of *Hevea* in the region.

Key words : *Hevea brasiliensis*, Growth, Environmental stress, North Konkan.

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INTRODUCTION

In India, *Hevea brasiliensis* is now cultivated in many potential regions, which are less congenial for the crop and Konkan region is one among them (Sethuraj *et al.*, 1989). In this region, prolonged cyclic soil moisture deficits and high temperatures during summer months are the major constraints for growth and productivity of *Hevea*. A few reports on the effects of these conditions on growth and yield are now available. Chandrashekar *et al.* (1990) reported very low yield and plant moisture sta tus and severe inhibition of transpiration and stomatal conductance due to soil moisture stress. Mohankrishna *et al.* (1991) reported severe inhibition of photosynthesis. However, no information is available on annual growth pattern of *Hevea* in this region for which the present study was taken up.

MATERIALS AND METHODS

This study was conducted at the Regional Research Station of the Rubber Research Institute of India at Dapchari (Lat: 20.04°N; Long: 72.04°E; Alt: 48 m MSL), North Konkan region in Thane district of Maharashtra. Data were collected from a trial laid out with 15 *H. brasiliensis* clones in 1985 in a randomised block design with three replications. The clones were : RRII 5, RRII 6, RRII 105, RRII 208, RRII 308, RRIM 605, PB 260, PB 310, PB 311, RRIC 52, RRIC 100, RRIC 102, RRIC 105, PR 255 and PR 261. The plots consisted of thirtysix plants at a spacing of 4m x 4m. Each plot had a common border row of plants belonging to clone RRII 118. Planting was carried out with two whorled polybagged plants. Cultural practices like manuring, life saving irrigation, weeding, mulching and white washing were followed for maintenance of

plants (Nazeer *et al.*, 1992). From 1991-92 dry season, irrigation was discontinued.

Data on monthly weather conditions of the location for the period of study (June 1991 to May 1992) were collected from the meteorological observatory near the experimental area. Daily variation in maximum temperatures for three typical months, *viz.*, November (representing initiation of stress), February (representing partial stress) and April (representing severe stress) were collected. Soil moisture conditions at two depths, 0-30 and 30-60 cm, were determined by gravimetric method with three replications for each depth, once in every month.

Girth of the trees at a height of 150 cm from the bud union was measured at monthly interval from June 1991 to May 1992 during the seventh year after field planting. This period covered a rainy season of four months from June to September and eight months of rainless spell from October to May. Girth values of all the three replications were used to calculate the monthly girth increments.

RESULTS

Meteorological data and soil moisture conditions of the experimental area are summarised in Table 1. The rainy period was from the middle of June to middle of September and there was no rain in the remaining months. Sunshine hours during July and August were very low (2.06 h/day), moderate in June and September (6.32 h/

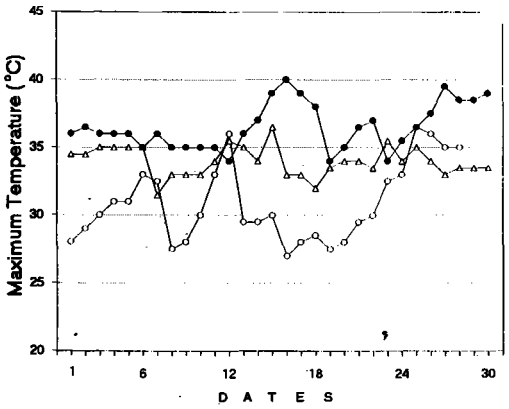

Fig. 1. Daily fluctuations in maximum temperatures during November 1991 (-Δ-), February (-0-) and April 1992 (-•-) at Dapchari

Table 1. **Meteorological and soil moisture conditions in the experimental area**

Month	Rainfall (mm)	SSD (h, min)	Tmin (°C)	Tmax (°C)	Evapo-ration (mm)	Soil moisture(%)* 0-30cm depth	30-60cm depth
1991							
June	225.8	7.24	25.7	33.3	4.8	34.0	36.3
July	1361.4	1.00	23.9	28.6	1.6	S	S
August	425.4	3.13	23.8	29.2	2.4	S	S
September	77.4	5.40	22.9	30.7	3.1	S	S
October	0.0	9.14	19.2	35.1	5.3	32.9	41.4
November	0.0	8.29	17.1	34.0	4.7	29.4	37.8
December	0.0	9.24	13.2	31.0	4.7	22.5	30.2
1992							
January	0.0	9.45	12.8	32.3	4.3	20.2	28.2
February	0.0	9.52	13.4	30.9	4.9	19.2	27.7
March	0.0	10.04	17.1	36.4	5.5	17.6	23.2
April	0.0	10.43	21.1	36.7	6.9	16.3	22.6
May	0.0	11.49	24.8	36.9	7.5	15.9	20.6

* Field capacity : 30.5% S : Saturated condition

day) and maximum (more than eight hours daily) in the remaining months. Daily minimum temperatures were low in the months of December, January and February (<13.5°C) and were fairly high in the remaining months. Daily maximum temperatures crossed 36°C during summer months (March to May). Evaporation was low in July, August and September (2.4 mm/day), moderate in June and October to February (4.7 mm/day) and high (>6.4 mm/day) during summer months.

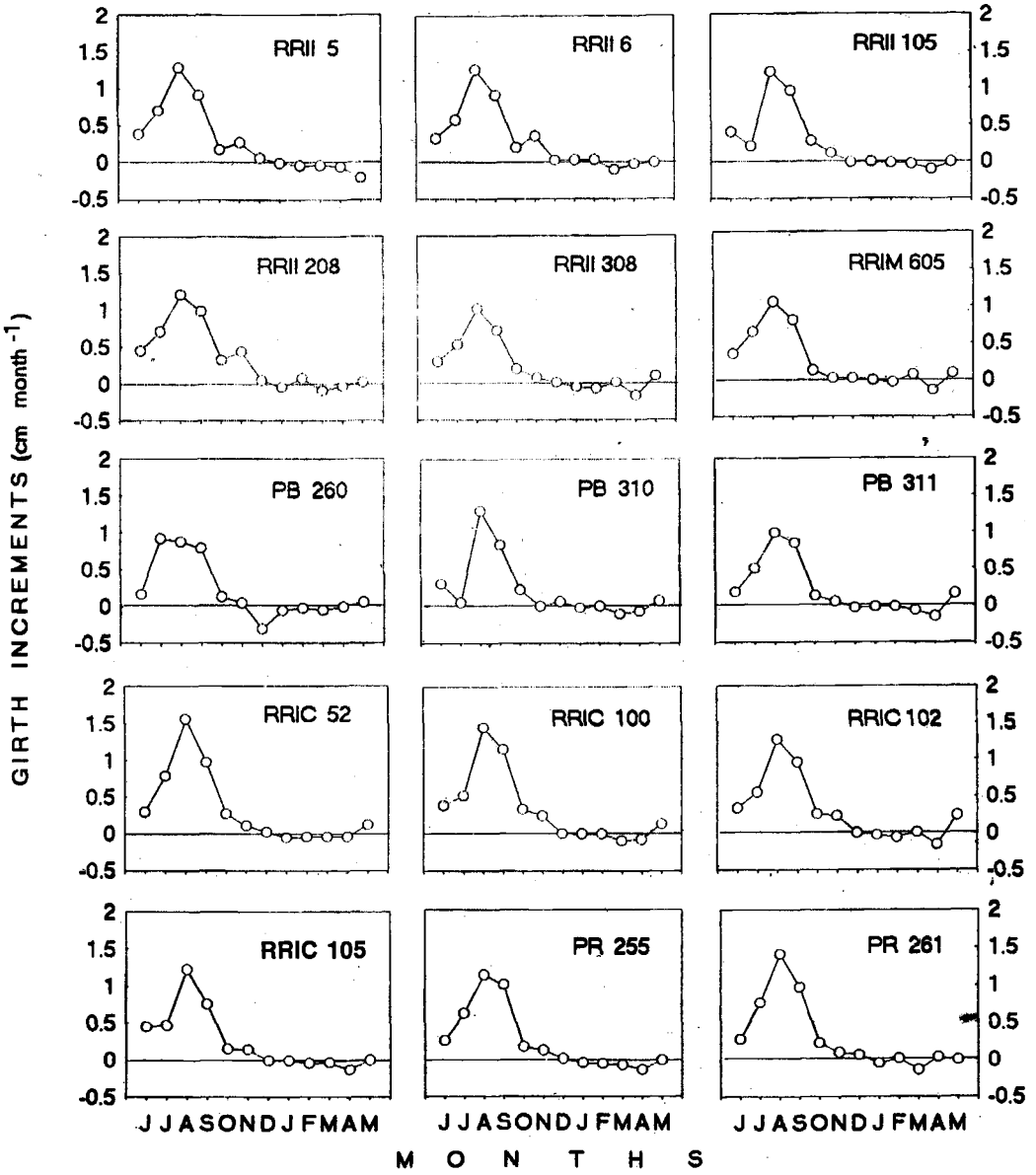

Fig. 2. Monthly variation in girth increments of different clones of *Hevea* in North Konkan during rainy (Jun-Sep) and dry (Nov - May) periods from June 1991 to May 1992

Soil moisture status was very good from June to November (>29%) and marginal from December to February (<24%). Summer months exhibited severe soil moisture stress (<20%) and towards the end of summer season, the soil moisture level was below permanent wilting point(PWP) (17.5%).

Daily variation in maximum temperatures for the three representative months of November, February and April are plotted in Figure 1. During November daily maximum temperatures fluctuated less and on most of the days it was below 35°C. In February it fluctuated highly between 26°C and 37°C. During April, maximum temperature on most of the days was more than 36°C and on some days it went upto 41°C.

Monthly girth increment variations of the clones are presented in Figure 2. All the clones showed almost similar pattern of growth. A little girth increase was observed in June itself with the onset of monsoon. In the following month all clones, except PB 310 and RRII 105, exhibited appreciable girth increase. In PB 310 and RRII 105, growth picked up after July. Growth was maximum in August for all the clones, except PB 260 in which growth was uniform during the months July to September. In September the growth started declining but still was substantial. However, in October very little growth was observed and it stopped completely during November and December. The growth started decreasing below zero and many trees of most clones showed a decrease in girth ranging from 0.2 mm to 0.5 mm from January.

DISCUSSION

In North Konkan, though the annual rainfall is rather high, its distribution is far from satisfactory. The entire rainfall is received in a short period from the middle of June to middle of September. This causes a long dry period extending from October to May. December to February are winter months. The summer period is from March to May, during which the drought conditions are very severe. In these months high atmospheric heat load and vapour pressure deficits with near PWP soil moisture conditions created adverse conditions for the growth of *Hevea* plants. Water deficits for the dry period of the region has been estimated to be about 1070 mm whereas it is around 350 mm in the traditional region (Rubber Research Institute of India, 1988).

A little growth observed for the clones in June may not be real and most of it could be due to the complete restoration of turgor which was lost during the preceding severe stress conditions. In the following month, appreciable girth increase observed for all clones, except PB 310 and RRII 105, indicated quick recovery after alleviation of stress. Maximum growth of all clones in August could be due to the compound interest effect of the previous growth.

It is well known that temperature and availability of water are the two major factors for growth and yield of plants. Further, when the ambient temperatures are above optimum, the substrates that could go into growth are increasingly lost through excessive respiration (Hellmers and Warrington, 1982). In the present study the progressive shrinkage of tree stems observed from January could be due to the continuous depletion of soil moisture accompanied by adverse atmospheric conditions. This type of continuous stem shrinkage for several days, weeks and months resulting from drought had been reported for many species of angiosperms and gymnosperms of the temperate and the tropical regions (Kozlowski, 1972).

During the monsoon period, eventhough most part of many days were cloudy with low sunshine hours, girth increase was very significant. From the results of an irrigation experiment conducted in the same location it has been reported that inspite of full potential irrigation during the dry period, maximum growth obtained was less than fifty per cent of the growth observed in the preceding monsoon period (Mohankrishna *et al.*, 1991). Therefore, it appears that *Hevea* prefers conditions of low vapour pressure deficits for good growth. In spite of no apparent limiting factors in the months of September and October, the growth of plants started decreasing and it stopped completely in November which is intriguing and needs to be investigated further. In *Hevea*, girth is the most important parameter for growth evaluation and for opening the trees for harvesting latex (Sethuraj and George, 1980; Paardekooper, 1989). Generally, the yield is positively correlated to girth within a clone. From the growth curves and the foregoing discussions, it is quite clear that in North Konkan active growth period of *Hevea* is about three months from July to September. It is known that annual growth rate determines the length of the pre-production period. From the results it is obvious that the conditions prevailing from October to May would prolong the immaturity period of *Hevea* in the region.

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